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THE

MINING INSTITUTE

OF SCOTLAND.

TRANSACTIONS,

Vol. IX.—1887-88.

HAMILTON:
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THE MINING INSTITUTE OF SCOTLAND.

TENTH ANNUAL MEETING

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON,

21st APRIL, 1887.

JAMES S. DIXON, Esq., President, in the Chair.

About 40 members were present.

The Minutes of the former Meeting were read by the Secretary.

Mr R. T. MOORE complained that his remarks in the discussion on the Committee's Report on the Mines Bill of Mr Childers having been altered by the omission of the transcript of Mr Justice Wills's decision in Corfield *v.* Evans, he had not had an opportunity of rendering them properly intelligible in view of that omission. He thought the decision of Mr Justice Wills was of sufficient importance to the members to warrant its being printed, especially as he was at considerable trouble to procure the transcript, the abstract which was published in the Iron and Coal Trades Review being incomplete.

The PRESIDENT explained that the Council decided against the insertion of the transcript as the information it contained was

available to members in the published legal decisions, but regretted that Mr Moore should think that the report of his remarks should have been damaged by its omission.

After some discussion about the sending of proofs to members the subject dropped, and the minutes were confirmed.

COUNCIL'S REPORT.

The SECRETARY read the report of the Council as follows :—

Your Council, in presenting the Ninth Annual Report would take occasion to congratulate the members on the very satisfactory state of the Institute at the end of the tenth year of its existence.

There were 481 members on the roll at the date of last annual meeting. During the year there have been 33 additions ; 7 have resigned ; 5 have died ; and the names of 33 have been struck off the roll on account of non-payment of subscription ; leaving at this date a total membership of 469.

The arrangement, which has been carried out for three years, of having the meetings alternately in Hamilton and Glasgow, appears to give general satisfaction ; and the average attendance is about the same at both places.

The following subjects were brought before the Institute during the year, either by individuals or by committees ; and the papers or reports on these subjects with discussions thereon have been printed in the Transactions :—

Burnett's Roller Mining Wedge and Drilling Machines.
An experiment to bring down coal by hydraulic means.
American Mining Machinery.
The Telemeter System.
The work of the Royal Commission on Accidents in Mines.
A Gauzeless Safety Lamp.
The Coal Mines Regulation Bill, 1886.
Settle's Gelatine Water Cartridge.
Self-Acting Brake for preventing Overwinding.
Pitkin's Miners' Electric Safety Lamp.
Sinking of Shafts.
Applications of Electricity to Mining Operations.

The Glossary of Scotch mining terms referred to in last annual report was completed during the year, and a copy of it has been sent to each member.

The Summer Meeting held at Carron and Falkirk was one of the most successful that the Institute has had.

Considerable additions to the stock of books and periodicals possessed by the Institute have been made during the year by purchase and exchange; and the Council would recommend the members to take more advantage than is now done of the valuable information on mining and allied subjects contained in the library.*

The following is a list of donations received during the year :—

From F. J. Rowan—A paper on Gas Producers—2 Copies.
,, Robt. L. Galloway—Mines Inspectors' Reports for 1857.
,, John B. Dalzell—Guide du voyageur aux carriers et mines de Svede par Gustave D'engeström.
,, Jas. M'Kinless—A Gauzeless Safety Lamp.
,, The Secretary of State—Mining and Mineral Statistics, 1885.
,, do., —Report of the Crarae Quarry Accident, 1886.
,, T. W. Stafford—Framed photograph of a Newcomen Engine.
,, Geo. W. Smith—Cape of Good Hope Official Handbook, 1886, and 8 photographs illustrative of Diamond Mining in South Africa.
,, Dalgleish & Coy., St. Helens—Framed photographs of Coupled Engines erected at Lady Windsor pits, Pontypridd.

There have been 17 meetings of Council during the year.

The PRESIDENT said the Report was very satisfactory, and they had reason to congratulate themselves on the position of the Institute.

FINANCIAL REPORT.

The SECRETARY read the following abstract of the treasurer's accounts for the past year duly audited :—

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* The library is now open every Thursday evening from 7 till 8 o'clock.

ABSTRACT OF ACCOUNTS for Session 1886-87.

Dr. **Cr.**

To Balance from 1885-86,					£193	5	11½	
,, 174 Members' Subscriptions at 21s,					182	14	0	
,, 242	Do.	do.	10s 6d,		127	1	0	
,, 1	Do.	do.	20s 6d,		1	0	6	
,, 2	Do.	do. in advance,	21s,		2	2	0	
,, 2	Do.	do. do.,	10s 6d,		1	1	0	
,, 6	Do.	do. arrears, at	21s,		6	6	0	
,, 7	Do.	do. do.,	10s 6d,		3	13	6	
,, Received for Transactions, &c.,					18	18	8	
,, Do.	Rents for Hall,				22	15	6	
,, Do.	Advertisements,				7	7	0	
,, Mining Exhibition Surplus,					27	14	9	
,, Interest on Bank Account,					4	2	11	
				£598	2	9½		

By Printing and Stationery,				£285	0 7
,, Books, Maps, and Bookbinding,				44	8 8½
,, Rents of Halls,				16	19 3
,, Gas and Assessments,				4	16 4½
,, Stamps, Carriages, &c.,				5	5 2½
,, Bookcase, &c.,				6	12 1½
,, Sundry Payments,				4	2 5
,, Cleaning Hall,				6	0 0
,, Salaries,				69	14 0
,, Balance in Bank,	£148	7	6		
,, Do. Treasurer's hands,	6	16	7½		
				155	4 1½
			£598	2	9½

7th April, 1887.—Examined, compared with vouchers, and found correct.

FRED. JNO. ROWAN,
J. B. DALZELL, } AUDITORS.

The PRESIDENT said—Though the balance was somewhat less, during the year there had been some extra charges which he did not think would be repeated. There had been a good many additions to the library, and the cost of the Glossary was considerable. They might take it that the income and expenditure would balance one another, those things being excluded. He thought, on the whole, they might consider it very satisfactory.

ELECTION OF OFFICE-BEARERS.

The CHAIRMAN announced that the gentlemen nominated at the last general meeting were now duly elected, viz. :—

President :

JAMES S. DIXON, 170 Hope Street, Glasgow.

Vice-Presidents :

JOSEPH T. ROBSON, Swansea.
JAMES SMART, Balgreen, Hamilton.
DAVID ANDERSON, Bothwell Road, Hamilton.
HENRY AITKEN, Darroch, Falkirk.

Councillors :

THOMAS ARNOTT, Summerlee Iron Works, Coatbridge.
ROBERT BEITH, Townlands Colliery, Hamilton.
ROBERT L. GALLOWAY, 98 West George Street, Glasgow.
JOHN GEMMELL, 96 New City Road, Glasgow.
JAMES GILCHRIST, Earnock Colliery, Hamilton.
ALEX. M. GRANT, Townholm Engine Works, Kilmarnock.
JAMES HASTIE, Greenfield Colliery, Hamilton.
JOHN HOGG, North Motherwell Colliery, Motherwell.
JOHN LOVE, Gartness Colliery, Airdrie.
HENRY MUNGALL, Cowdenbeath Colliery, Cowdenbeath.
JAMES PRENTICE, Stanrigg Collieries, Airdrie.
FRED J. ROWAN, 134 St. Vincent Street, Glasgow.

The following were elected by ballot as Ordinary Members :—

ALEX. B. ALLAN, 67 St. Enoch Square, Glasgow.
J. C. ADAMSON, Victoria Place, Airdrie.
ROBERT HAMILTON, Derwent Villa, Crosshill, Glasgow.
JAMES FREW, Dalmellington Iron Works, Waterside.
JOSEPH REID, St. Enoch Square, Glasgow.

PRESIDENT'S ADDRESS.

GENTLEMEN,—I have again to thank the members of the Institute for electing me as their President for the third time.

The Institute continues in its course of usefulness, the subjects treated during last session being of a varied and instructive character.

We had first a description of Burnett's roller mining wedge and drilling machines. This was followed up by experiments with these machines, conducted in Greenfield Colliery by a committee of the members, which demonstrated that the drilling machine was well adapted for rapidly boring holes of large diameter suitable for the wedge. They also showed that the wedge was a very powerful instrument for the purpose for which it was designed. The failure in some instances to do all that was expected of it cannot be taken as evidence that in some circumstances it might not be most useful in breaking down coal. The inventor claimed that the use of the wedge makes more and better round coal, which is most material; but, unfortunately, the experiments were not so conclusive on this point as was desirable. Probably the only way to satisfactorily test this and the work to be done by the machines would be a regular working trial extended over a considerable period, such as might be done if Mr Burnett would take a contract of the output of a pit in which he could employ his own men to hole and prepare the coal to suit the wedge.

We had also a description by Mr Beith of an unsuccessful attempt made by him to bring down coal by hydraulic means. It was found that the escape of water through the pores of the coal prevented the necessary high pressure from being obtained.

Mr Ralph Moore gave us a description of American mining machinery, which he had observed in a recent visit to that country, illustrative of several highly ingenious contrivances for a variety of purposes.

The telemeter system, brought under the notice of the Institute by Mr Rowan, was descriptive of management made

easy, as the operations in the various departments both above and underground could be instantly recorded in the office by electricity. It was suggestive of a well-arranged system of record indicators, and an arm-chair, good fire, and other comforts.

Next we had Mr Gemmell's very elaborate and exhaustive criticism of the work of the Royal Commission on Accidents in mines, the main features of which were clearly brought before us and well discussed.

We had also a description of a gauzeless safety lamp by Mr M'Kinless, for which the inventor claims certain advantages. This and the discussion which followed led to the appointment of a committee to experiment and report on the best lamp to be used by drawers, pony drivers, and others who have to move about, as a substitute for the Scotch gauze lamp, which has been long in use for this purpose.

The summer meeting in August was held in Falkirk, and included the inspection of Carron Works, which have during recent years been remodelled and fitted with the most modern appliances under the direction of one of our members. At this meeting there was a paper by Mr Begg on the Mines Regulation Bill of the late Government. This afterwards resulted in the appointment of a committee of our number, who carefully considered the various enactments proposed in the Bill, and reported to the December meeting the results they had arrived at. The report, after being exhaustively discussed, was adopted at the meeting in March. This was perhaps not the least valuable work done by the Institute during the year; and, so far as I know, is the only case of a Mining Institute treating this subject in such an exhaustive manner, which the members are in the best position to do from their great practical knowledge of the subject in all its phases.

In September and November we had before us reports of experiments made at Earnock and Bog Collieries with Settle's gelatine water cartridge in conjunction with the high explosives manufactured by Nobel's company. While these experiments clearly demonstrated the safety of the water cartridge in quenching the flames produced by the ignition of the explosive, they were not so successful in bringing down the coal to the

extent and in the round condition so much desired. In this respect powder seems to be peculiarly suited to what is required of it, having a comparatively slow rending effect. Those more immediately interested in the introduction of water cartridges in conjunction with higher explosives must endeavour to attain this slow rending action, combined with moderate cost, before they can expect their more general adoption.

Mr M'Pherson's self-acting brake for preventing over-winding appeared to be more applicable to geared engines with slow motion of the rope drum than to the quick winding now almost general.

A miner's electric safety lamp by Mr Pitkin was the introduction to the Institute of a very interesting subject. A general expression of opinion was given that electric light in some form will be the future light in our mines. The lamp described gives a good light, which is of first importance. However, it is rather heavy for a travelling lamp in a low working. The chief hindrances to its introduction are its first cost and the expense of upkeep of the film, and having to provide a dynamo to charge the lamps, it being a secondary battery. It is to be hoped this subject will be worked out to a practical solution before long.

Mr Beith's paper on sinking and fitting shafts is most valuable as giving the details of various appliances for facilitating work of this kind, and also of the manner shafts are fitted for winding and pumping.

The last paper of the session was by Mr Rowan on the application of electricity to mining operations. No subject can be of more interest to those engaged in mining than that of the transmission of power to distances from the prime motor. In no other industry is this so much required, pumping and hauling having to be done at long distances from the shafts, in situations where it is impracticable to have steam boilers, and to where power can be taken by ropes or compressed air or water only at great expense and loss by friction and otherwise. Mr Rowan's object was to describe how this was and could be done by electricity. The subject being new will take some time to gain the confidence of the public, who have a feeling that there is some danger in its action; but it is gaining favour, and its advantages

are so apparent that, if it realises anything like what is reported there is a wide range for its application in connection with mines.

I cannot pass from a review of the proceedings of last session without mentioning the production by our Secretary, assisted by other members, of a Glossary of Scotch mining terms, which, from its completeness, will remain as a text-book for many years to come.

Outside our Institute, many valuable contributions to our knowledge of mining subjects have been made. Foremost among such I would place the work of Messrs W. N. & J. B. Atkinson on explosions in coal mines, which is well worthy the careful perusal of all interested in this subject. This work describes the effect of six considerable colliery explosions—five in Durham and one in Cumberland. Plans are shown descriptive of the workings, and of the effects observed after the explosions, which enables any one practically conversant with the subject to draw his own conclusions, as well as follow the very clear descriptions of the authors. The Cumberland explosion is clearly traced to an accumulation of fire-damp, the explosive mixture which fired occupying a space estimated at upwards of 32,000 cubic feet. The roads in the vicinity of where the explosion took place were damp and free from dust. The effects of this very large quantity of explosive mixture being ignited were quite local, the force losing itself in the workings and doing comparatively little damage. Although the disturbance of the air was observed at a distance of about a mile from the site of the explosion, still there was no flame carried 50 yards beyond where the gas existed, as men in the immediate vicinity escaped unhurt, although their lamps were blown out. The Durham explosions treated of were all in dusty mines. This dust was in the main intake airway and haulage roads, and was of a kind which, I am glad to say, is seldom met with to such an extent in our district, being fine impalpable coal dust chiefly blown from the hutches in their passage outwards at considerable velocities against large volumes of air going in. This dust is not only on the pavement, but lodges on every irregularity of the sides and roof and on the timber supports. When this is so, the dust is ready to rise in clouds on the least agitation of the air caused by a shot or the

ignition of a small quantity of gas. A train having thus been ignited, the explosion, supported by the dust, travels on, sweeping everything before it so long as the supply of dust lasts.

Four of the Durham explosions are traced to the firing of shots in places where there was much fine dust, and the fifth to the likely ignition of a small quantity of fire-damp at the end of a dusty haulage road. In one of the former, the shot was in the brushing where the air would contain a small percentage of fire-damp which was given off by the coal to windward, and in the other three they were fired in main intake airways through which large volumes of fresh air, direct from downcast shafts were passing, and in the most disastrous case, the shot was fired in the haulage road, near the pit bottom, with 61,000 feet of fresh air passing per minute. In these cases the presence of fire-damp in the air was practically impossible. One curious but notable feature was that for a distance of 50 to 75 yards on each side of the shots and supposed origin of the explosion no timber was displaced or damage done to the roads. This was not marked in the case where the explosion was supposed to originate from the firing of the gas. The conclusion to be drawn from this is, that an explosion of fire-damp originates force at and does damage from its origin, whereas a dust explosion from a shot gradually accumulates and gathers force as it travels, and that at its origin the concussion merely raises and ignites a cloud of dust in the air, which has no force till it is fed with further fuel.

Since the work of Messrs Atkinson was published an explosion took place on 2nd October, 1886, at Altofts Colliery, which was the subject of an official inquiry and reports to the Home Secretary by Messrs Barker & Wardell. The roads in this colliery were very dry and dusty, the scene where the explosion took place being 215 fathoms from the surface, and the temperature 70 degrees. Watering the roads to some extent was resorted to, to lay the dust. The finding of the jury and reports on this case are unanimous that the explosion was entirely due to coal dust alone. The circumstances were: After the colliers had left the pit on a Saturday afternoon, some men were employed blasting stone to straighten a main haulage road. Two shots had been fired, which no doubt had raised a cloud of dust, with which every-

thing was covered, and a third shot that had been unskilfully drilled was then fired. This shot did little work, and was practically a blown out shot. These shots were fired about 500 to 600 yards from the pit, in a main intake, which was swept by a current of 50,000 cub. feet of air per minute, and it was quite impossible that any fire-damp could be present. Like the other cases referred to, the road where the shots had been fired was only slightly damaged for a distance of about 80 yards on each side of the spot, whilst the roofs fell in, and doors and timbers were burned, and great damage done in places extending to upwards of a mile distant. So great had the force increased by the time it reached the pit bottom that the haulage engines there were broken and destroyed.

In all the cases referred to, the effects of the explosions were almost entirely confined to the air-intake roads, the stoppings, doors, &c., being all blown from the intakes towards the return airways. The intake airways were also used for haulage, and were very dusty. Where this was not the case near the shaft in some cases, or where there was sufficient water to damp the dust, the explosions died out and ceased. In the Altofts case, the report says—"The return roads were all in good order; indeed, it appeared, whenever the coal dust ceased, that is, when out of the roads subject to dust from the transit of the corves of coal, there also ceased the evidences of explosion." The coal faces throughout the mine bore no trace whatever of the explosion. The conclusion can confidently be drawn that three of the Durham explosions described by Messrs Atkinson and that at Altofts were explosions without fire-damp, caused by firing shots which raised and ignited the fine coal dust; this then acted like a train of gunpowder, the torrent being fed and gathering force as it swept along, and continuing so long as the supply of ammunition lasted.

In reading descriptions of colliery explosions from time to time, they seemed always to happen in the best ventilated and managed pits in their districts. A feeling of despair was apt to seize those who were most familiar with mining, as it appeared that fire-damp, which was until lately considered the only cause, could burst out in the most unexpected places and cause explosions. This feeling must now be relieved; but another is engendered by

the fact that is now proved that coal dust and air in a dry mine are explosive with far more disastrous and widespread results than fire-damp in a damp mine. Half of any difficulty is over when the real cause is discovered, and it is abundantly proved that it is extremely dangerous to fire shots in main intake and haulage roads in which there is dust. This should not be done without such precautions being taken that a cloud cannot be raised, and in any eventuality, that it cannot be ignited.

I may remark that the two most disastrous explosions in our own district—viz., at Nitshill and Blantyre Collieries—were in two of our dustiest mines, and I have no doubt their fatal and widespread effects were attributable to this, whatever may have been the first causes.

I am sorry to have again to record continued depression in mining, there having been a total decrease in the output of all minerals classed under the Coal Mines Regulation Act, during 1886, as compared with the previous year of 3,217,000 tons the decrease of coal being 1,832,936 tons. Scotland also shows a large decrease in the output of coal from 21,288,586 tons in 1885, to 20,373,487 tons in 1886, although about 2000 more persons were employed in the latter year. These figures, with the decline in preceding years, are the best proof of a languishing industry, to revive which, by the adoption of the most approved means of production and preparation of the produce to meet the market is one of the best arguments for the existence of such an Institute as our own, and I trust that during the session on which we have now entered, it will go on and prosper.

Mr DAVID ANDERSON moved a hearty vote of thanks to Mr Dixon for his address. He had given them a very clear outline of the proceedings of the past year, and he hoped that their success would be as great in the one they had now entered on.

The motion was cordially agreed to.

The following paper on "A Mining Tour through South Africa" was then read by the Secretary.

A MINING TOUR THROUGH SOUTH AFRICA.

By GEO. W. SMITH, M.E., Government Surveyor, Port Elizabeth.

It has been well said that South Africa is a colony of surprises. Perhaps more books have been written about South Africa than about any other colony, and still it is a country which is but little understood outside of its own boundaries. It is famed for its wars and hunting grounds—for its Boers who shoot well, and its Kaffirs who fight well—and that is about all that is popularly known about it. The diamond mines, among other things, have made it a little more popular within the past few years among a certain section, but as for attracting a population to settle on the lands, or develop its mineral wealth, it has not been so far a successful colony. Thousands of emigrants pass its very door on their way to the more attractive Australias, situated at double the distance from England, whose lands are by no means superior to the Cape, and where competition has now reduced the price of productions to about English rates. Perhaps the explanation of all this might be found in the one fact, that in South Africa a large portion of the land has been held by either Dutch or those in strong sympathy with them, who have an hereditary antipathy to progression and the importation of fresh blood; and so the best efforts of the comparatively small English population have had, until lately, hard work to make headway. But, happily for the land and happily for the people, these days are rapidly passing away, and although Dutch habits are still pretty firmly rooted at the Cape Town end of the Continent, the Eastern Province—of which Port Elizabeth is the chief seaport—is to a large extent an English-speaking community, and English ideas, habits, and customs have made very great strides during the past twenty years. Railways have a wonderfully civilising effect, and as the iron road inaugurated fourteen years ago stretches now some five hundred miles inland, old prejudices are getting broken up, and there is an increasing desire throughout the land by the better class of Dutch parents to bring up their children on English lines, and an improvement in this respect is seen in all departments.

But if this was a difficulty on the seaboard, where the English

influence was strongest, it was much more an obstacle to progression across the Vaal River—the land of the present gold discoveries—where it became a crime against the State, and punishable by heavy penalties, to search for gold; where the hatred against all things English was kept well to the front, and which culminated in the late unfortunate Boer war, when our troops were out-generaled and slaughtered. It is in this land that a large number of our most hardy pioneers have been prospecting for gold for many years past, and whose account of their wonderful discoveries reaching us were looked on as "travellers' tales." Happily for this land, too, and for the people, the road from Kimberley on the one side—which passes Bronker's Spruit—and from Natal side on the other—with its Majuba Hill and Laing's Nek of sad memories—is now in full possession of the British digger, who is swarming up in very skirmishing order indeed, armed with pick and shovel, to attack the Transvaal quartz reefs, and the whole aspect of affairs is suddenly changed. There is now a fusion of interests little dreamt of formerly. The Dutch confess to stand more in awe of the British digger with his bowie and revolver than they did of the British soldier and his heavy impedimenta, and have sufficient sense to move with the tide. Perhaps the presence of the British sovereign in such quantity has something to do with the altered state of public opinion, as quite recently the country was on the verge of bankruptcy, and with a heavy British indemnity debt to pay, and an empty treasury. So low indeed were their funds, that it is reported in Pretoria their civil servants had sometimes to be paid in gunpowder from the Government factory; but to-day the coffers are filled to overflowing, and many thousands of pounds come in monthly in excess of all possible requirements. The Raad or Parliament are endeavouring to keep abreast of the times. Telegraphs are projected, large sums are set apart for roads, public buildings, hospitals, &c.; and this for a community that shut up their post offices, telegraph offices, and public offices between twelve and two o'clock each day, is a wonderful stretch of progress.

These facts are mentioned because in some of the English papers it has been stated that the South African gold fields are

situated in a foreign state. In one sense this is true, but as all the privileges are enjoyed (even to the Limited Liability Act) of an English community, it is of little practical consequence what the nominal rule is designated by. With amazing rapidity the Dutch are altering their ways to suit the times, the latest concession being to allow the English language to be spoken in their law courts. It may be briefly stated that the diggers are perfectly satisfied with the present rule. There are some details as to customs duties and such like which are considered rather stringent, and these the Dutch Raad or Parliament have agreed to modify. However, as the English population is daily increasing in number, it does not require the gift of prophecy to predict that a short time must alter the method of the present government machinery to a more modern pattern.

About the end of September last a party of three Special Dutch Commissioners arrived at the Barberton Gold Fields from Pretoria, the seat of government, and the diggers, wishful to show their loyalty and good fellowship, determined to hoist a flag of welcome. The Dutch flag was accordingly run up on the halyards of the Phœnix Hotel flagstaff, but was immediately hauled down by some enthusiasts and the British ensign substituted. This did not seem quite right either, so by some ingenious arrangement the two were hoisted together side by side, when a breeze of wind came up and the ensign swept round the Dutch flag and folded it in its ample embrace, and the Dutch flag was seen no more. This may be an allegory of what is yet to be.

With this rather long prelude it may be stated that the object of the present writer's tour of inspection was to report on certain gold properties in the Transvaal, with regard to development and future working. The journey was continued into Swazieland, lying between the Transvaal boundary and the Indian Ocean.

The first stage of the journey was by rail to Kimberley, a distance from Port Elizabeth of 485 miles. The Transvaal gold fields can be reached by way of Natal or Delagoa Bay; but although these ports are nearer to the town of Barberton than Port Elizabeth, the roads are so rough as to make the detour of

little consequence, the Port Elizabeth and Kimberley route being through a healthy country, well watered, and one which can be travelled all the year round.

Kimberley is the chief centre of the diamond industry. There are several outlying townships, but these are, to a certain extent, suburbs of Kimberley. The town contains about 18,000 inhabitants. The houses are chiefly of corrugated iron, but a large number of the more recent buildings are built of brick or stone.

Notwithstanding that the mining is done not in the open as formerly, but for the most part underground, the output of diamonds keeps well up. Some two years ago the open workings became so dangerous and so often interrupted by falls of reef, that there came a time of doubt whether the mines could be worked at all from underground, but one company after another adopted working their ground as a colliery and found it could be done; so that mining the "blue" is now pretty generally adopted throughout the mines.

The "blue," or substance containing the diamond, has been found at the increased depth to have become much harder; indeed, it has now the appearance of rock. An incline, or, in some cases a shaft, has been sunk from the surface, the mouth of which is outside the margin of the mine, and the bottom of the incline or shaft communicates with the underground workings in the usual way.

The mine is opened up on the stoop and room principle, the pillars being irregular in size but averaging about 30 to 40 feet square, and the openings about 20 feet wide. The height is rather irregular, varying from 6 to 20 feet. The workings are driven to the boundary of the property, and the pillars as well as the blue ground in the roof between the successive levels is taken out in the second working.

The method of taking out the blue from the pillars and the roof seems to be somewhat similar in each of the mines, but the *modus operandi* is a little different. Beginning at the hard rock which forms the outside casing of the mine, the blue is dropped from the roof in sections, and the excavated stuff is allowed to lie on the pavement to form a sort of scaffold for the miners to work from. The miner goes on in this way rising higher as the

blue is excavated from the roof—this is done for the full length and width of the drive. The miner thus excavates upwards till he reaches near the bottom of the next drive above, which has previously been filled with rubbish, in fact, "stooped"; the roof barrier is then broken through by putting in charges of dynamite and firing the lot when ready with electricity, and the debris from above comes flowing in and fills the remainder of the chamber already made. The loose blue already excavated is then drawn off through a wooden shoot previously inserted into an adjoining open working at a lower level, and conveyed to the surface in tubs. The loose debris fills up the space as the blue is drawn off, and when one section is finished another is begun, the debris going down stage by stage as the blue is excavated. It is said that in this way very little of the blue is lost.

The process seems to a stranger a highly dangerous one, but may not be so on more intimate knowledge of practical details. As far as could be seen, no props or supports were used in the mine visited, but in some the timber used is great, and the work done for the most part by Kaffir labour. The only alternative to working in this way is to clear out the whole mine again and work opencast. The value of the blue is stated to average £4 10s per cubic yard in the mine, so that there is every incentive to exhaust the whole seam. So far there have been no serious accidents through caving in of the blue; but to the casual visitor there is a feeling of uncertainty regarding the stability of the workings. Some huge caverns thirty feet or more high by a like width cause one to wonder how it all holds together, and if some day when the sides or abutments, as they may be called, of the various blocks of claims are partially worked, the balance of the whole will not be disturbed, and result in a cave in.

For some time before underground working was resorted to, the prospects of the diamond mining industry were rather clouded owing to the uncertainty of its being practicable to continue work at all, but now that it has been demonstrated that the blue can be worked from underground, the value of diamond mining property has considerably increased and prospects generally have improved. There is no appearance of the blue giving out at any of the mines—the experience is that it gets richer as a

greater depth is reached, and the probability is that the present output, in value amounting to about three million pounds sterling per annum, will be continued for many years to come. The profits made are enormous, and even in the depressed times wonderful dividends have been paid on large capitals. One company, for instance, having a capital of half a million pounds paid back in three years, a sum in dividends amounting to £300,000, and this is not an isolated case by any means.

Somewhere about 10,000 natives and 1200 European miners and artizans are employed daily about the mines, together with 2500 horses. There are 350 steam engines of various descriptions used, and 160 miles of tramways are laid to convey the blue away from the mines. About two million pounds are annually spent in wages, &c., and as Kimberley is at present the terminus of the railway and the depôt for stores for the interior trading, its trade is prosperous, and it is one of the most important centres of commercial activity in the colony.

Passing now onwards to the gold mines of the Transvaal, the journey at present is accomplished by passenger waggon to Pretoria, the capital of the Transvaal, in two and a half days from Kimberley. The distance is about 340 miles, but during the coming session of the Colonial Parliament it is intended to push on the railway to the Vaal River, where the Colony ends and the Transvaal begins, a distance of about 40 miles. Recently a concession was given by the Transvaal Government to continue the line from the Vaal River to Pretoria, but at the last moment some difficulty about customs' duties between the Colony and Transvaal broke off negotiation. No doubt the gold development will revive the question and probably before long the line from Port Elizabeth to Pretoria, either through Kimberley or Colesburg, will be an accomplished fact. The country is level all the way and there are no engineering difficulties.

The coach traffic is at present rather hampered on account of a short supply of horses and coaches, but this will doubtless be remedied, as a number of American travelling waggons have arrived to take up the trade of conveying passengers.

The first point on this route where gold has been really found is at Clarksdorp, about 40 miles on the south on Kimber-

ley side of Potchefstroom. It is found here in the same description of conglomerate as at the Wittewaters Rand, which is 80 miles further on; but so far nothing is done to develop it, owing, it is understood, to some doubt about the ownership of the ground on which it has been discovered. The first town reached is Potchefstroom, the former capital of the Transvaal, a well-situated town with a magnificent water supply from the adjoining Moi River.

From various portions of the country round, samples of gold-bearing quartz have been brought in, but there has been nothing done so far to develop the enterprise in this locality. All prospectors are intent on reaching the known gold fields further on.

To reach Wittewaters Rand fields, the nearest way is through Potchefstroom, but the coach continues its journey through to Pretoria. Pretoria is now the capital of the Transvaal. It is a well watered town, having streams running down both sides of the street, tall trees along the footpaths, and many good houses; but the streets, footpaths, and general belongings are entirely neglected. There is no town council or municipality, no taxes or rates levied, no streets lighted or repaired—everything seems to manage itself. Government offices, post and telegraph offices, religiously close every day at twelve o'clock, and open again about two; and until quite recently the town and people had fallen into a state of coma, the result of long years of trade depression, following on the withdrawal of English capital and enterprise on the retrocession of the country to the Republic by the British Government. All this is now changed as if by magic. The town is filled with diggers from all parts of the colony, and the hotels are filled to overflowing. Gold is the one topic of conversation. Property has vastly increased in value, and there is a new hope and a new day dawning for the Transvaal; and there is little doubt but that these gold discoveries will do more to level race distinctions and blend the two races of Dutch and English into one than regiments of soldiers and conquest.

The Wittewaters Rand gold fields are about 40 miles south of Pretoria—that is, towards Kimberley—and so far as has yet been discovered, extend over a tract of country 40 miles long from east to west by 6 miles broad; but as traces of the same

deposit are found over a much larger area, it is at present impossible to define the extent of these fields. The fields are situated on the High Veldt, some 5400 feet above sea level, a particularly healthy district at all seasons of the year. It is a well watered country, and all descriptions of cereals grow well there. It is thus most favourably situated for supporting a large population. There is no timber suitable for mining purposes nearer than 40 miles; but when a trade springs up there will be no difficulty in procuring it, the roads from the "Bush Veldt" being good. In Australia it is no uncommon occurrence to carry mining timber 50 and 60 miles to the shaft.

The character of this deposit is new to most people. It consists of a series of reefs cropping up within a few feet of the surface, and dipping with great regularity about 60 degrees from the horizon, and in a southerly direction, composed of a conglomerate of water-worn pebbles, varying in size from that of a pea to that of a walnut, firmly held together by a cement of a white limey nature. These reefs vary from 2 feet to 20 feet in thickness, and can be traced for miles along the outcrops. The Dutch call this sort of reef "banket," from its resemblance to a sort of sweetmeat they have, like "almond tablet." There is not one reef alone, but many, and of different varieties. In one trench of 200 feet long as many as six reefs were counted, varying from 3 feet to 18 feet in thickness. Some contain gold in greater degree than others, but it is quite uncertain as yet which reefs carry gold in the most payable quantity. Even on the surface there is a good "prospect." In almost every dish a good show of gold can be had on "panning off," but as the excavations deepen the gold-bearing nature of the reef gets more defined. An analysis of fourteen different parcels made by the Government analyst, gives an average of 1 oz. 14 dwts. 2 grs. per ton. Some samples (not included in this list) gave 9, 27, 38, and 92 ounces respectively to the ton, but these are exceptionally good. The gold is not only coarse, but remarkably free and unmixed with pyrites, and the general opinion is that the yield will increase with the depth. Several large trials of 25 and 50 tons of mixed reef gave 1½ ounces of retorted gold per ton. The gold is of good colour, but the value was not ascertained—£3 12s 6d per ounce was offered and refused.

The reefs all run in the same direction, viz., about 80 degrees N.E. Besides the "banket" reefs, there are reefs of sandstone, &c., all gold bearing; but little is known yet below 50 feet down as to what are valuable, and whether the reefs harden into quartz or die out, and speculation is busy as to the manner in which the reefs came there—whether they are alluvial deposits or true reefs. The steep angle they are tilted to, viz., 60 degrees, and the number of them, seems to upset the alluvial deposit theory; but as several companies are now engaged sinking shafts, something more definite is likely to be known shortly. The whole country is pitted over for many miles with trenches, holes, trial shafts, &c. Several blocks of claims have been taken up by companies formed in Kimberley, Cape Town, Pretoria, and Port Elizabeth, and orders for several hundred head of stampers and other machinery have gone to England. One company seems so satisfied with the cheap manner in which these reefs can be worked, that they estimate, with their battery of 100 stampers and a yield of ¼ ounce to the ton, that some £70,000 profit will accrue to the company.

Of the considerable number of people on the fields very few seem to have had any experience of mining outside of hauling blue out of the Kimberley open mine, and it appears as if they had rather under estimated the difficulties of working out these reefs, unless some radical change comes over them and the side walls. Both the hanging and foot walls are, as a rule, soft, and of a crumbly nature, and will require much careful timbering, especially those reefs which are 18 feet thick. Where these reefs come close together, it may perhaps be found best to work the whole as an open quarry for a time, at all events till the ground hardens.

Another question requiring consideration is the treatment of the "banket reef" before crushing. The cement would be best separated from the pebbles. Both contain gold, but the pebbles want crushing, while the cement would be better left as it is, so that the stuff would not cake in being stamped. It is to be feared a number of companies have ordered "batteries" totally irrespective of the work required to be done, in the excitement to be first in the field. One or two minor points want consideration, and will no doubt receive due attention

by and by. There should be a good field here for mining managers with a knowledge of steep workings and pumping water, as it seems highly probable that before long there will be considerable water in these mines. There is an abundance of water in the streams, and as their source is not far from the reefs, water is pretty certain to be tolerably abundant in the reefs, and the "water level" pretty low.

In some portions of the field there is water power sufficient to work small machines, but generally steam power will have to be depended on for working the mines and driving the mills and machinery. There are few hills as at Barberton, where "day levels" can be driven; everything must be raised to the surface. Fortunately there is an abundance of fairly good coal, about 40 miles distant, cropping out on the hill sides, thick and easily worked. It is not yet opened out, but no doubt will be very soon. It can be laid down at about 20s per ton on the fields at present, and doubtless this will be reduced when a quantity is taken.

These fields only date from about July last. In September and October they were thrown open to the public, that is, so much of them as was not already leased from the owner. Government are now receiving about £15,000 a month in license fees from these and other fields. A prospector's license costs 20s per month; claim licenses cost 20s per month each, besides various fees and allowances. Farmers who a few months ago hardly possessed any money, and lived on poor food, in miserable broken-down houses, sometimes windowless, with mud floors, find themselves now suddenly courted by speculators, and money flowing in to the extent of thousands of pounds.

The fields are easy of access; labour is pretty plentiful at a cheap rate, that is for ordinary surface work—Kaffir labour being employed. A large quantity of machinery is now on its way up, and results will soon be known. As a rule, the mills ordered are for companies owning claims; but several central mills have been spoken of, by which means private claim holders could work their own lot on tribute or shares, and this is likely to be the case with a good number of small properties.

A "claim" measures 150 feet along the reef, by 400 feet at

right angles to it. Twelve claims are generally "massed" or put together, and called a "Block," which can be registered as a company concern, and the parties to whom the 12 claims belong are free to peg off a second time. Only one claim can be held by one individual at a time.

There are one or two 5-stamp batteries already on the fields, used for testing purposes, but it is a matter of note that at these fields, and also at the Barberton fields these appliances are far from being perfect, and the wonder is that the results of the crushings are so good. The batteries are of a good pattern, but the mercury plates are short and steep set, and the blanket strakes are sometimes absent. Mercury troughs there are few, and as for "Berdan pans" or "Vanners" these were only seen at Barrett's Berlyn (noted further on), so that the results of gold found are not exceptionally high; but with better appliances and more skilled amalgamators, a much higher yield will no doubt be obtained.

Before leaving the Pretoria district it may be noted that there are various gold bearing districts within a radius of say 100 miles of Pretoria. The Waterberg district is said to be peculiarly rich in gold quartz, and several other districts are heard of most favourably from time to time; but the presently opened up fields of Wittewaters Rand and Barberton are engrossing so much the attention of our sparse population that these outlying fields are neglected. The farms, besides, in this part of the country are still unsurveyed, and a difficulty arises as to the proper boundaries and ownerships if gold is found. This will be rectified soon, when no doubt these other districts will receive proper attention.

The whole belt of country lying between the 24th and 26th degrees of south latitude it is believed is all more or less gold bearing, extending from the Portuguese territory on the east, to Bechuanaland on the west. The climate is healthy, and as the altitude of the country is high—from 4500 to 5500 feet above sea level—the heat in summer is dry and by no means oppressive.

To reach the Barberton fields, which are about 280 miles due east from Pretoria, and in the direction of Delagoa Bay, the usual method of conveyance is by post-cart, which occupies two-and-a-half days on the journey.

The road is in good order all the way. As far as Elands Spruit

the gradients are easy. At this point there is a descent into the valley, and an ascent to the Devil's Kantoor; the pull is a long one, but not steep. At the Devil's Kantoor there is a small alluvial diggings where about seventy men are at work. The water supply up there is scarce, being on the top of a hill, and all the water rights have been taken up, or this diggings would be rushed. Some large nuggets have been found here, and the alluvial workers are believed to be doing very well.

Near the Devil's Kantoor is the Barrett's Berlyn property, belonging to an English company. The quartz being excavated from the open quarry on the top of a hill is of a brown, earthy, crumbly nature. It is run down to the battery site, some 1500 ft. vertical by a series of tramways. There are thirty stamp heads at work at this mill, driven by water power, by means of a Turbine or Pelton wheel, the pressure guage registering 150 lbs. per square inch. The works are well arranged, and the appliances for catching the gold are good, but the quartz is said to be difficult to treat, and the returns are not satisfactory. Some fresh management is being arranged which may help matters; but the stampers seem heavy for the quartz, and the arrangements seem to have the same defects as already noted, viz., too heavy for their work and unsuited to disintegrate the friable stuff; the water power is ample for many more stampers, and it is possible that by lightening the weight of the stamp heads, and increasing their number, a better result might be obtained. The pulverised quartz receives more attention here than it does at any of the other batteries visited; the plates and blankets are ample and well arranged; there are Berdan pans and the usual furnace and smelting rooms; and on the whole the arrangement is a relief to see after the slip-shod appliances witnessed at other parts of the fields.

Leaving the Kantoor eastwards, we descend into the Kaap Valley, some 1200 feet, and the town of Barberton is seen 27 miles off through the haze, perched on a spur of one of the high hills which rise behind the town. On a nearer approach we find it to be of the usual mushroom character peculiar to "diggings"——partly brick, partly corrugated iron, partly clay—and a great deal of mixed architecture beyond description.

There is the usual crowding in from all the various parts of the country round, all descriptions of vehicles filled with expectant diggers,—men on horseback and men on foot,—while other streams of humanity are setting in the direction of outlying settlements. What a few months ago was an almost uninhabitable waste is now the centre of a large digging population, estimated about 10,000, with daily increasing numbers. In the town itself there are not more than about 4000, the rest being scattered over the hills prospecting, or camped out in the vicinity. The houses are few and building material scarce. At date of visit, some ninety houses were stopped building for want of wood and corrugated iron for the roof; recently however this has been remedied. It would unnecessarily lengthen this account to mention some of the peculiarities of this style of living. It is rough in the extreme; beds are almost unknown luxuries, insect life is plentiful and lively, but the rough and general loafer is conspicuous by his absence. The inhabitants as a class are most orderly, many of them being young fellows who have served in the Zulu and Bechuanaland campaign, and would form a rather formidable muster of good shooters and excellent horsemen.

The "diggings" are on three sides of Barberton, among the hills behind the town, and which are some 2000 to 3000 feet high. To the east towards Delagoa Bay the quartz reefs have been traced for over sixty miles. To the west the gold farms of Moodie's Company (Limited) formed the boundary for a time, but the prospectors are now away beyond this to the Komati, which has lately been declared by Government as a gold field. The accounts from them are very good.

At Moodie's, about eight miles to the west of Barberton are the oldest workings in the Kaap Valley. The Pioneer Gold Mining Company, a small private company composed of five or six individuals, are working a reef which two years ago they had attempted to float as a public company, but failed. In face of much difficulty and little capital, these men had so much faith in the reef that they opened it up themselves, purchased a five-stamp battery, and cut a water race some three miles long over most difficult country. The reef was 2½ ft. wide on the top, but narrowed to 9 in. at 160 ft., but has again

widened to 2½ ft. at 300 ft., and the last crushing has yielded 3 ounces to the ton of quartz. The mine is paying handsomely. New batteries are purchased and are being erected; the work is well managed, and is as well "stoped," ventilated, and otherwise engineered, as the best of the Sandhurst mines. Several other mines are being worked here—"Whiteheads," "Beehive," "Natalia," "Tiger Trap," "Rosetta," "Union," and several others. These are getting their batteries erected, and the whole of the valley will soon be lively with the clatter of the battery stamps. The gold here is remarkably pure, and is valued at £4 0s 6d per ounce.

All the batteries here are worked by water power, conveniently situated to the mines. There is, as a rule, no carriage of stuff from the mine to the battery, the quartz going direct from the adit level to the stone breaker, and the mines are worked by day levels. The crowns of the reefs are high up in the hills, so that a drainage level of 700 feet or more is easily got, and of course a corresponding height of available reef is commanded by the level. Moodie's terms are considered rather high, being a royalty of 8 per cent. on all gold found, whereas Government have an optional royalty of only two-and-a-half on gold found. This rather prohibitive tax is likely to be modified, but the situation of all the mines on Moodie's farms so far, is exceptionally good for economical working. The average of many hundreds of tons crushed has been 1¾ ounces to the ton. The climate here is at all times good; the height is about 4000 feet above sea level.

Returning to Barberton, the mountains rise steeply behind it to a height of over 2000 feet. Prospectors are busy among the hills, and some rich reefs have been discovered there. Some samples were shown of a transparent quartz with gold inlaid in the centre of the specimen, which had a wonderfully beautiful effect. The gold is visible in patches in most of the Transvaal reefs, aud is of all colours, from white like marble to dark blue, and almost black. Some sample crushings of the transparent quartz gave a yield of 4 ounces to the ton.

Around Barberton there is no machinery erected as yet, with the exception of a 5 stamp battery used for testing purposes.

Along the Queen's River, some five miles from Barberton, there are two more batteries, viz., that of the "Caledonian" and "Victoria" Company, worked by water power and driving ten stamps each. But with the exception of these, there was no gold machinery on the fields at date of visit. The number of water sites pegged off by prospective company floaters is overwhelming; for miles along the creeks and rivers the ground is applied for, and in some cases machinery is under order. During the driest month of the year the water in most of the creeks and in all the rivers was sufficient to drive all the machinery required, and this after a drought of seven months' duration. Since date of inspection many batteries and plant have arrived. At one time no fewer than 1000 transport waggons were on the road to Barberton with machinery, etc.

About ten miles to the east of Barberton is situated the famous Sheba Hill, the summit of which is 2500 feet above sea level. On this hill is a small township designated "Eureka City," which probably at some future date will assume considerable dimensions.

All the richest mines so far discovered are in this locality. The "Sheba Quarry" is situated on the face of the steep hill looking down into the valley, and is simply a high mass of rock, the face being at an angle of about 70 degrees. It has been pierced or tunnelled at various points in the 700 or 800 feet it is in view, and everywhere it yields good gold, running some 7 to 8 ounces to the ton, some sent to England yielded as high as 30 ounces. The exposed face of the quartz is about 60 feet across at the top, and the reef has been proved at various points down the hill. The £1 shares sell at £52, and real work is not begun yet.

Alongside this mine are several more famous mines, the "Edwin Bray," formerly portion of Sheba, also of the "quarry" variety, and of great extent. 850 tons of this stone yielded at the rate of 7 ounces of gold to the ton.

The "Oriental," a similar mine, said to be of good stone, and a number of less famous properties are in the vicinity. A short way off—still on the Sheba Hill—is Thomas's, a small property, consisting of two claims only, said to be very rich. It was found

by the Brothers Thomas and sold by them to a Company for £60,000. The shaft is only sunk 70 feet, but all the way down the quartz is studded with gold. The shaft is sunk in a "shoot" of gold, and is locally known as the "Jeweller's Shop." There have been no crushing yet in quantity, but the sample tests have been very rich.

There are about 30 different mining properties on this "Sheba Hill," and numerous prospectors are searching after other Shebas and Thomases. There is no water on this hill, so that all the quartz will have to be taken by ærial trams to the valley below the Sheba hill, and conveyed by a steam tramway, at present in course of construction, to the Kaap River, a distance of about eight miles, where there is a plentiful supply of water at all times. About 100 stampers are to be put up here at once, and the Fig Tree Creek junction with the Kaap River is all pegged out for water races, town lots, &c., extending over a large area. As all the quartz must come down this short railway and all the supplies go up to mines, this line, if economically worked, should give as good a dividend as some of the gold mines.

Away further to the eastward is a large scattered population engaged in prospecting over the hills for 40 miles and more towards Delagoa. The list of reefs found is a long one, and it is added to daily almost. The Caroline Reef, about 18 feet wide, has been pegged off for at least 10 miles along its outcrop. It is a one ounce reef. Then the Kimberley Imperial Reef is a rich one—about 4 ounces to the ton—but its outcrop is lost, and the extension of this reef has been pegged off for some miles in one or two directions, according to the fancy of the peggers how it should run. Then come the "Honey Bird," "Cascade," "Big Ben," and many others, all in a state of embryo. These reefs are high out of the valleys and fairly well situated for water; but, in the rush for claims and the subsequent selection of water sites, a great deal of trouble and expense in working might have been saved with a little judicious planning. The battery sites are in many cases badly selected, and at inconvenient distances from the portion of the various reefs they are intended to work; and, except some re-arrangement of claims and sites or a general amalgamation for joint tramways and

batteries takes place, some of those companies who have not provided capital for long roads and heavy maintenance will have some difficulty in making ends meet.

There is neither wood nor coal in the immediate neighbourhood, but these can be had at moderate prices. For a time the mines can be worked by day levels. The timber and water questions are the two most important questions on some of these reefs, and the wide reefs will be rather expensive to timber and "stope."

Travelling still eastward, the territory of the Swazi king is entered. This country is also laid under tribute to disgorge its mineral wealth. Nearly the whole country is granted under various concessions, the first to Forbes south of the Komati River, and at present being opened by an English Company, and said to be very rich. Coal is also found on it. On the north of the Komati River are M'Lauchlan's concession, Pigg's concession, Wylde's and Somershield's concessions—in all of which are rich reefs. On Pigg's concession is a mountain of sugary sandstone called "Pigg's Peak," running nearly an ounce to the ton. A 40 stamp battery worked by water power is in course of erection. The whole of this country is well watered with large streams and plentifully timbered, some trees being eight feet in diameter and of a most durable wood. The country is easily approached from Delagoa Bay, and material can be imported without incurring the import duties of the Transvaal. The mountains are about 3500 feet above sea level. The valleys are marshy in places, but the hills are habitable all the year. Very little is known of the country and its mineral wealth, as Swaziland has been a forbidden country to the prospector so far; but the country has every appearance of being rich in gold, and a few years' occupation of a mining population will bring civilisation into the present home of the lion and crocodile.

This was the termination of the inspection, and the return to Port Elizabeth was by the same way as the journey was made up.

Until quite lately the development of these gold fields has been entirely by Colonial capital and Colonial labour, but within the past few months there has been a considerable influx of British capital. The banks have not in any way encouraged the floating of companies, or advanced monies on mining properties. Some-

thing like 1½ millions of Colonial capital has been subscribed up till the present time, and the fields are hardly touched as yet. It will be some months before there can possibly be any returns of gold, as the first of the machinery is only arriving from England; but a short time will practically demonstrate the fact that South Africa is rich in gold. There are still vast tracts of unexplored country to prospect, and doubtless there are many more rich reefs yet to be found.

Some years ago, an alluvial diggings at "Pilgrim's Rest" induced a number of Australians to come over; but the diggings were short-lived, and many of the Australians returned rather disappointed, so that some doubt may exist in Australia about these present discoveries. Besides, there are counter attractions in the famous Mount Morgan mine in Queensland and the Tasmanian discovery at Port Macquarie; but, no doubt, when it is fully established that these reefs are of such vast extent and richness as they undoubtedly are—for undoubtedly the Transvaal is a reef country rather than alluvial—there will be a large accession to the present comparatively small English population, and South Africa may then hope to make some substantial advance to get abreast of the other colonies. She has been heavily handicapped in the race by native wars and Boer rebellions, by Africander Bonds and a vacillating policy, and if any proof were wanted that the country was in many respects a wonderful one, it is to be found in the fact that it has for many years supported a population, a large proportion of whom do absolutely nothing, many who do the little they have to do in a thoroughly slovenly manner, with a small percentage of hard-working Dutch and English, who have kept the credit of the land from falling into disrepute.

What is especially required at the present time is an influx of a mining population. There is no lack of money to develop and willing hands to work, but there is a great want of trained men to direct. With very few exceptions those engaged in mining are new to the work. The experience of most has been in the Kimberley Mines, excavating from the "open" and hauling to the surface. There is a good class of men on the field, active and intelligent, but a great amount of random labour is being done

evidently from want of some well-matured plan for future developing and working. Some of the companies have sent to Cornwall and Australia for trained men, and this defect will no doubt be rectified at most of the mines, as well as the substitution of perfect crushing and amalgamating plant for that now in use. Large orders have gone to England for the latest improved machinery and gold-saving appliances, so that this too will be put right shortly, when no doubt the already handsome yields of gold per ton of quartz will be largely augmented.

One feature of the development of these fields strikes one as of doubtful advantage—viz., the large capitals and extensive tracts of country taken up by some of the companies, including areas and lengths of reef not likely to be utilised for many years to come, and which could be very well split up into several smaller concerns and be more readily handled; but the country is so large, and the population so small in comparison therewith, that the temptation is doubtless great to own large properties. Much could be said regarding heavily-weighted companies the number of whose vendors' shares forms a very substantial proportion of the whole of the share list; but as this is an old business, and likely to go on till company forming is no more, it need only be mentioned in passing, as not having been overlooked. No doubt when share lists are more difficult to fill up this state of matters will be improved, and promoters, prospectors, and others be satisfied with more moderate rewards.

This subject might be fitly brought to a conclusion by giving an extract from the opinion of an Australian expert, lately arrived to report on the country for a considerable number of Australian miners, who are ready to come on if the report of their representative is favourable. He says :—" In Australia we speak of pennyweights; on the De Kaap Fields you talk of ounces, and you have got them. Over the water it is a matter of the very cheapest method of working, and if this is regarded on the De Kaap fields you have unquestionably the richest gold fields in the world. And where you have so many reefs—with Barberton in the centre—of something like 5000 square miles of defined leads, there can be no question as to the ultimate discovery of alluvial. In Australia so far they know little of the

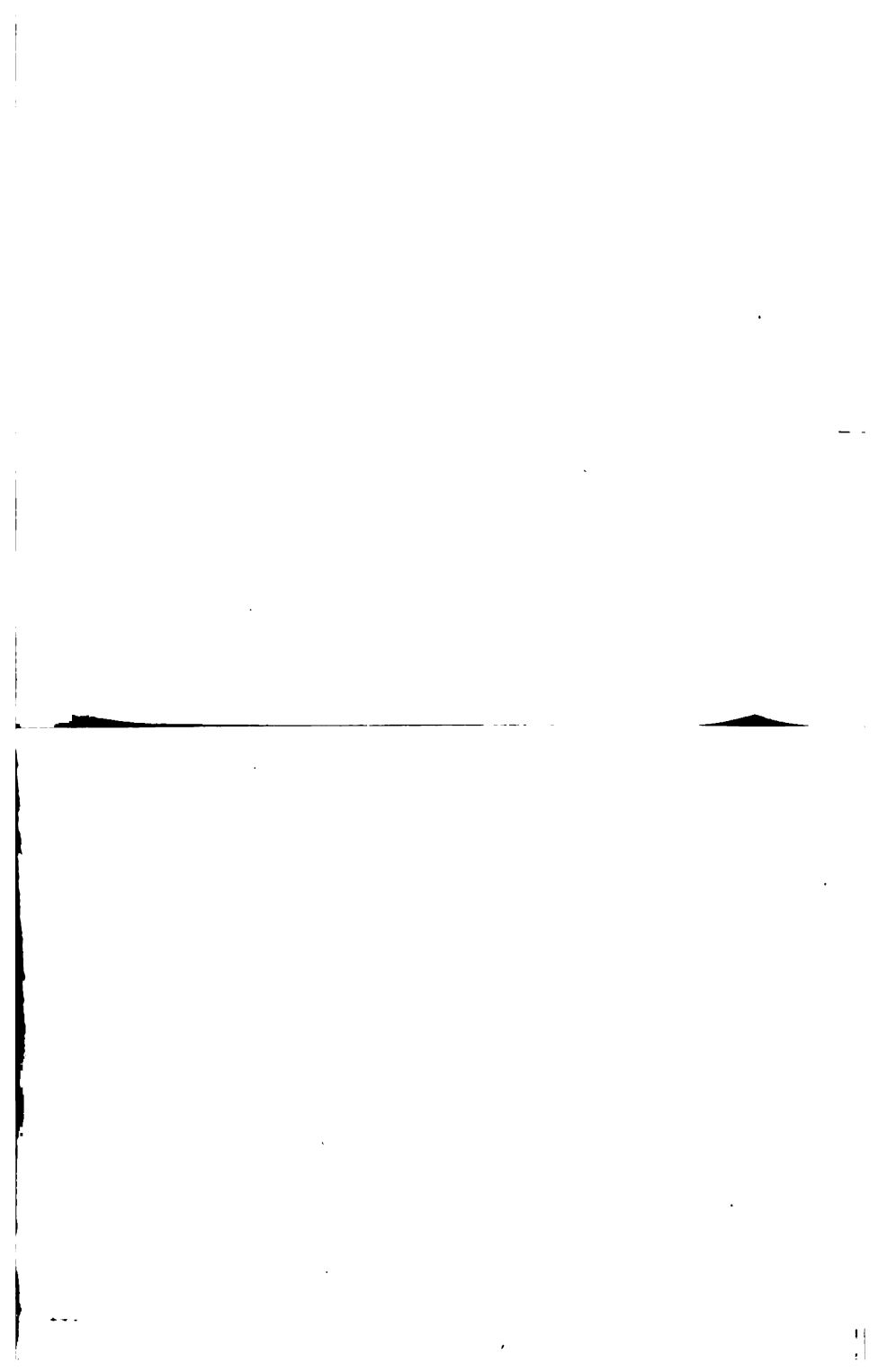
De Kaap fields, but with proper representations there will be thousands ready to come over and try their luck here."

It is quite out of place in these notes to mention what might be done with this land that has been left undone. Its capabilities are unbounded, and these gold discoveries appear to be the very tonic needed to bring about a healthy condition of things, and fill up the land with industrious workers. Railways will shortly extend from the sea-board to the mines, giving facilities for reaching them. The climate is healthy, and the soil, with its magnificent water supply, capable of supporting a very large population.

DISCUSSION.

The PRESIDENT said he thought this was a paper that they were not in a position to discuss, but they would leave it open to next meeting. He thought it was very pleasant that members who left them and went abroad should continue to take an interest in the Institute, and send descriptions of mining going on under their superintendence. They were all very much obliged to Mr Smith. (Cheers.)

The PRESIDENT submitted for discussion the following Report by the Committee on the Mines Bill, which had been previously sent to the members.



REPORT of the COMMITTEE on a Bill to consolidate with amendments The Coal Mines Acts, 1872 and 1886, and The Stratified Ironstone Mines (Gunpowder) Act, 1881, prepared and brought in by Mr SECRETARY MATTHEWS and Mr STUART-WORTLEY, 1887.

AT a general meeting of the Institute, held on 10th March last, it was remitted to the Committee that had reported on Mr Childers's Bill of 1886 to examine the Bill prepared by Mr Secretary Matthews and report to a future meeting. Accordingly, after the Bill had been printed, the Committee met and carefully considered at two meetings the various clauses of the measure, and they have to report as follows :—

In the opinion of the Committee, the Bill has been, on the whole, admirably drawn up so as to provide, to the extent that can be done by legislation, for the safety of the workmen employed in connection with mines, consistent with fair and reasonable restrictions as to the working details ; and they notice with satisfaction that a considerable number of the recommendations contained in their report on Mr Childers's Bill have been carried out in this Bill.

There are a few of the provisions, however, which, in the view of the Committee, admit of improvement ; and these will now be referred to in the order in which they occur. (Quotations from the Bill are printed in small type.)

PART I.

EMPLOYMENT OF BOYS, GIRLS, AND WOMEN ABOVE GROUND.

Clause 8. . . . . .

(4.) No boy, girl, or woman shall be so employed between the hours of nine at night and five on the following morning, nor on Sunday, nor after two o'clock on Saturday afternoon.

It is still the opinion of the Committee that it is unnecessary in the interests of the boys, girls, and women to cause them to stop work at two o'clock on Saturday, and it is recommended that "four o'clock" be inserted. The Bill does not allow them to be employed more than fifty four hours in any one week, so that they are fully protected against excessive work. In collieries where picking and cleaning of the coal at the pithead is done by

boys and females, the whole work of the pit has to be stopped when they cease work; and, in order to get a day's work on Saturday, the practice is resorted to of starting work earlier on Saturday morning; thus putting hundreds of men to considerable inconvenience, and with no corresponding advantage to the parties on whose behalf the early start is made. At many collieries work is not carried on for six days a week, from various causes, so that in such cases, even with the later stoppage on Saturday above proposed, the length of employment is much less than fifty-four hours per week.

CHECK WEIGHER.

Clause 14. . . . . .

(3.) The check weigher shall not be authorised in any way to impede or interrupt the working of the mine, or interfere with the weighing [*or weighing machine*], or with any of the workmen or with the management of the mine; but shall be authorised only to take such account as aforesaid, and the absence of the check weigher shall not be a reason for interrupting or delaying the weighing.

(4.) If the owner, agent, or manager of the mine desires the removal of a check weigher on the ground that the check weigher has impeded or interrupted the working of the mine, or interfered with the weighing, or with any of the workmen, or with the management of the mine, [*or has made known to others the weights, beyond informing each person by whom he is employed the weight of his individual output*], or has at the mine, to the detriment of the owner, agent, or manager, either done anything beyond taking such account as aforesaid, or otherwise misconducted himself, he may complain to a court of summary jurisdiction, who, if of opinion that the owner, agent, or manager shows sufficient primâ facie ground for the removal of the check weigher, shall call on the check weigher to show cause against his removal.

(5.) On the hearing of the case the court shall hear the parties, and, if they think that at the hearing sufficient ground is shown by the owner-agent, or manager to justify the removal of the check weigher, shall make a summary order for his removal, and the check weigher shall thereupon be removed, [*and shall not again be eligible for employment as such at any mine belonging to the same owner*], but without prejudice to the stationing of another check weigher in his place.

The Committee think that the words in italics should be added. The Bill provides (see clause 34, sec. 3) that the Secretary of State shall not publish the return of the quantity of mineral gotten at any individual mine; and it is only reasonable that the

check weigher should likewise be prohibited from making known the output unless to the extent of informing each person who employs him, the weight of his individual output.

If a check weigher, discharged at the instance of the owner, agent, or manager, for misconduct at the mine, can be again employed at the same mine, or at an adjoining one belonging to the same owner, irritation between owner and workmen will probably arise, and it is very desirable that occasions for such should be avoided.

Clause 15.

(1.) Where a check weigher has been stationed by any of the workmen employed in any mine, and has acted as such, he may recover from any of the workmen employed in the mine by whom he was so stationed his proportion of the check weigher's remuneration.

Reading this clause, in the light of the Memorandum appended to the Bill, it appears that the check-weigher is not to have power to claim wages from these workmen who do not employ him. This, in the opinion of the Committee is fair and reasonable; and it would be well, to prevent misunderstanding, that the meaning be more explicitly stated.

NOTICE TO BE GIVEN OF OPENING AND ABANDONMENT OF MINE.

Clause 37. . . . . .

(iii.) Where the working of a shaft or a seam of any mine is recommenced after any abandonment or discontinuance for a period exceeding two months . . . . . the owner, agent, or manager of the mine shall give notice thereof to the inspector of the district, &c.

A particular seam of a mine otherwise in active operation, may not be worked for a period of two months in a dull season. The Committee think that the purpose contemplated would be served if the period stated here were *six* months instead of two.

APPOINTMENT OF INSPECTORS OF MINES.

Clause 40.

(1.) A Secretary of State may from time to time appoint any fit persons [*holding a first-class certificate as manager under this Act*] to be inspectors (under whatever title he may from time to time fix) of mines, and assign them their duties, and may award them such salaries as the Treasury may approve, and may remove any such inspector.

The insertion of the words printed in italics is recommended. It is of consequence that Inspectors should have qualifications

equal at least to those of the Managers, whose modes of carrying out the provisions of the Act they may have occasion to criticise.

PART II.—RULES.

Rule 10.—In any mine or part of a mine in which safety lamps are required by this Act or by the special rules made in pursuance of this Act to be used— . . . . .

(iv.) A person shall not have in his possession any lucifer match or apparatus of any kind for striking a light, except within a completely closed chamber attached to the fuse of the shot.

The meaning of the latter part of this sentence (iv.) is obscure, and, in the view of the Committee, should be more clearly expressed, so that there may be no room for doubt as to what it covers.

Rule 12.—Any explosive substance shall only be used in the mine below ground as follows :

(*a*) It shall not be stored in the mine ;

(*b*) It shall not be taken into the mine, except in cartridges in a secure case or canister containing not more than five pounds.

. . . . . .

(*c*) A workman shall not have in use at one time in any one place more than one of such cases or canisters, *except where shots are fired by a competent person as after provided, who may have in use at one time five such cases or canisters.*

If dynamite or other high explosive be used the quantity stated is enough in ordinary circumstances; and in mines where the firing of shots is not restricted, and where the workmen fire their own shots, five pounds of gunpowder is sufficient for each ; but in cases where the number of men is limited when shots are fired, the competent person who is to fire the shots should, in the opinion of the Committee, have liberty to take a larger quantity of gunpowder into the mine for use at one time, and they would recommend the insertion of the words in italics.

It is gratifying to the Committee to find, after a careful examination of the Bill, that their views as regards all its most important provisions are in accordance with those of the framers of the Bill, and gives encouragement to believe that the above

suggested alterations, if approved of by the Institute, will receive that consideration from the Legislature which will insure their adoption.

On behalf of the Committee,

JAMES S. DIXON, *Convener.*

DISCUSSION.

The PRESIDENT said that the Bill had been very carefully considered by the Committee. Unless there was something of great importance he thought it would be well not to discuss the report at great length, but to approve, if possible, of the recommendations of the Committee, which could then be sent on to the proper quarter. If there was anything members wished to suggest should be added to the report, they would be very glad to hear it.

Mr F. J. ROWAN said the Mines Bill bore such evidence of the work of the recent Royal Commission on Accidents in Mines that it seemed a pity, as the Commissioners had pointed out, that such valuable labour should be lost by the dissolution of the Commission. As this Institute had a good claim to be considered not merely a highly practical but also a scientific body, he thought they might with propriety support the recommendation of the Royal Commissioners that such a body should have a permanent existence.

Mr ANDREW WILSON, referring to Rule 12, sub-section (g), said it appeared to him that this was a little too stringent, because there were many cases in which gas might be issuing and not accumulating, and where men were working with naked lights. In such circumstances he did not see that there was any necessity for using water cartridges or withdrawing the men during shot-firing. He knew several cases where gas was issuing and they were working with naked lights, and blasting with powder, but under this Act the use of those unnecessary precautions would be required, involving increased cost.

Mr DAVID ANDERSON said he had seen in a mine neither dry nor dusty an accumulation of not more than a bonnetful of gas

and none issuing. It would be a hardship if under such circumstances men had to be withdrawn from long distances for shot-firing. It had been mentioned that, in the earlier stages of the water cartridge, the results were scarcely satisfactory. If this were so it would render the carrying out of the work under the restrictions proposed more difficult and expensive than necessary. He thought safeguards were a very good thing, but a mine-owner might be supposed to have also a great interest in preserving his property.

The PRESIDENT said a mine might be driven in a district where gas existed and yet the air might be adequate to dilute it. Yet, under this rule men would have to be withdrawn, which he thought was serious. He would propose the insertion of the words "so as to render the use of locked safety lamps necessary." That would remove the difficulty to some extent.

After further discussion it was moved by Mr J. B. DALZELL, seconded by Mr JOHN AUSTINE, and unanimously agreed that the Report of the Committee be adopted with the following additions :—

RULE 12.

(*g.*) In the case of a mine which is not dry and dusty, if in any ventilating district inflammable gas has been found issuing or accumulated within a week previously, [*so as to render the use of locked safety lamps necessary,*] a shot shall not be fired in that district with gunpowder or blasting powder unless all workmen are removed from the district, except those engaged in firing the shot, &c.

(*h.*) In the case of a mine which is dry and dusty, then—(i.) If in any ventilating district inflammable gas has been found issuing or accumulated within four weeks previously, [*so as to render the use of locked safety lamps necessary,*] a shot shall not be fired in that district with any explosive unless the explosive is used with water or other contrivance so as to prevent it from inflaming gas or dust, or is of such a nature that it cannot inflame gas or dust, or unless all workmen have been removed from the district, except those engaged in firing the shot.

Cases are not rare in which gas may be issuing from the working face to such a trifling extent that, although the faint sound of its issue may be heard, its presence cannot be otherwise detected; and the occasional occurrence of a cap-ful of gas in a ventilating district, in a crevice, or at a long distance from the site of a shot, is not incompatible with perfectly safe blasting.

The above suggested additions in italics would do away with what in some instances would be an unnecessary restriction, at the same time tending to secure that degree of safety which all so much desire.

In view of the many new subjects connected with mining that are emerging from time to time, the recommendation made by the Royal Commission on Accidents in Mines at the close of their final report of 15th March, 1886, is one in which the Institute cordially concurs and would be glad to see adopted.

The recommendation of the Royal Commission is as follows :—

"In bringing our labours to a termination we feel very strongly that many of the subjects with which we have dealt need much further elucidation by perseverance in experimental research of the kind which we have pursued. We are convinced that if the work which we are relinquishing were continued the knowledge of the conditions to be fulfilled for securing safety from preventable disasters and the development of resources and appliances calculated to promote the fulfilment of these conditions could still be much advanced."

"It is moreover certain that new subjects for inquiry connected with the safe working of coal mines must continue to present themselves, as has been the case during our seven years' experience. These considerations have impressed upon us the need for the official establishment of some permanent arrangement by which the continuous pursuit of this highly important class of work would be secured, and by which also the merit of suggestions and inventions presenting themselves from time to time would be investigated promptly and thoroughly and dealt with authoritatively."

The following report by the Committee on Safety Lamps was submitted by Mr ROBERT BEITH, the Convener, and held as read :—

REPORT OF THE SAFETY LAMP COMMITTEE.

In accordance with a resolution of the General Meeting held in Glasgow on 30th September, 1886, the Council appointed a Committee to inquire after and report on a substitute for the Scotch gauze lamp. The Committee was composed of Messrs David Anderson, Robert Beith (convener), Archibald Blyth, James Gilchrist, James Hastie, John Love, James Prentice, Hamilton Smith, and Henry Telfer.

In conformity with the instructions of the Council, your Committee put themselves into communication with the following firms, who willingly supplied the various types of safety lamps that were considered desirable for the experiments contemplated. The Committee received—

From John Davis & Sons, Derby.

1 No. D Clanny bonneted, leadlock, Stokes's shut off appliance.
1 No. I Mueseler „ „ „ „ „
1 No. M Marsaut „ „ „ „ „
1 No. N „ Screw Lock.
1 No. P Davis-Ashworth Mueseler, leadlock, Stokes' shut-off.

From James Ashworth, Stanley, Derby.

1 Ashworth Mueseler.
1 Gray's patent lamp, as improved by Ashworth.
1 Complete Ashworth Mueseler, with inner and outer shields.

From the Protector Lamp and Lighting Company, Manchester.

1 Protector Mueseler, with fast shield.
1 „ „ „ loose „
2 „ Marsauts, or double gauze lamps, with fast shields.
2 „ „ „ „ loose „ The loose shield is fastened on the top of the lamp with a lead plug.
2 Double Gauze lamps, to burn colza oil, with loose shields locked to the body of the lamp by a screw lock.
2 Double Gauze lamps, to burn colza oil, with loose shields and brass pillar screwed to the top of the lamp.
4 Protector Marsauts, with cone around the burner to keep the flame from impinging on the glass, with loose shields, and side hook fixed on to shield.
1 Protector Marsaut, special make, with large diameter of glass.
1 Davy, with glass cylinder outside of gauze.

From Evan Thomas, Aberdare.

1 Cambrian lamp, No. 7, B 6, screw lock, without shut-off.
1 „ „ „ with „
1 Marsaut lamp, own make, lead lock.
2 Cambrian lamps, No. 7, iron shield, 1st pattern, lead lock.
1 Mueseler, Celynen pattern.

From George Salter & Co., West Bromwich.

6 Safety lamps, all of one type.

From the Proprietors of Morgan's Lamp Patents.

6 Morgan lamps, all of one type.

From James Milne & Son, Edinburgh.

12 M'Kinless's Gauzeless lamps.

From J. Mills & Sons, Newcastle.

1 Marsaut lamp, burning colza oil, with ordinary screw lock and patent pillar lock and case.
1 Marsaut lamp, burning colza oil, with lead plug and patent pillar lock for case.
1 Marsaut lamp, burning colza oil, with Ryder's patent pillar lock, locking both bottom and case.
6 Marsaut lamps, burning spirits, with ordinary screw lock and fast shields.
3 Marsaut lamps, burning colza oil, with ordinary screw lock and Stokes' shut-off arrangement.
2 Donald tin can Davy lamps.

The Committee had seven meetings.

Experiments were made above-ground with a variety of the different types of lamps at a meeting attended by most of the members of Committee. It was not deemed advisable that any of the lamps should be subjected to an exceptionally severe test; but in experimenting with them it was assumed that a condition such as follows had occurred, viz., that they had been carried into a body of fire-damp, or that fire-damp issuing quietly from the waste had completely surrounded the lamps before the workmen had suspected the presence of it. The Committee were convinced that in such an event the gas would continue to burn in the whole of the shield safety lamps for some time after the light had left the wick, and when to outward appearance the light had

been extinguished. They observed that lamps in that condition got so rapidly hot that it was almost impossible to operate the shut-off appliances.

Subsequently the lamps were distributed among the nine members of Committee, and they were thus brought into practical use under-ground, and the experience of the firemen and general oncost men was obtained and utilised for the object of this inquiry.

Thereafter each member of Committee reported in writing his individual experience and observation. A considerable body of opinion is given in favour of the continued use of the Scotch gauze lamp in ordinary conditions, being portable, light, handy, and remarkably efficient. For a substitute for it, for use by colliers, the Protector Mueseler is preferred by some; one member prefers it for all purposes; the Marsaut lamp with double gauze, and burning naphtha, is recommended by nearly all; and the same lamp, but burning colza oil or combination oil, for firemen, roadsmen, drivers, and drawers. One member signified his opinion that the Marsaut would cost less per year for repairs than the Scotch gauze, while another recommended it on account of its comparatively simple construction, its mode of action being easily understood, and of its illuminating power being fully equal to most of the other lamps. For firemen, the tin can Davy, as being useful in strong currents of air, is in two reports recommended to be carried. All the best safety lamps had glasses, and unless the lamps were carried upright the glasses got smoked. A suggestion in one report, and intended to obviate smoking, advises that the Marsaut should not have any side hanger, but that the ring on the top of the lamp should be made long enough to project somewhat over the side of the lamp, so that a man could readily place it in his belt with one hand only. The usual round ring hanger causes the lamp to cant to one side when placed in the belt, besides taking both hands to put it in. One member remarks that the hanger being on the top of the lamp, and thus lengthening it, is awkward for drawers, especially in snibbling. Another report alluded to the lightness of the Scotch gauze lamp as compared with the heavy safety lamps submitted, and the more decided tendency of the

latter to get hot. It also stated that the shield or covering over the gauze was calculated to do harm rather than good in ordinary general use, though admittedly advantageous in a strong current of air. Having regard to the many kinds of underground workings throughout the country, and the very different conditions existing in each, two members are of opinion that no single lamp submitted is suited to all collieries.

In conclusion, your Committee are of opinion that the Scotch gauze lamp has done good service in the past, and might still in many of the mines in Scotland be used to advantage by the general oncost men. They however believe that in mines where gas is being given off in quantities so large as to require strong currents of air to dilute and render it harmless, a lamp of different construction is necessary. They beg to submit, as the result of their investigations both above and below ground, that in such mines a lamp of the type of the Marsaut, burning colza or combination oil, should be carried by oncost men, and the Protector Mueseler or Marsaut, with spirit, by colliers or stone workmen.

Reported by

ROBERT BEITH.
DAVID ANDERSON.
ARCHD. BLYTH.
JAMES GILCHRIST.
JAMES HASTIE.
JOHN LOVE.
JAMES PRENTICE.
HAMILTON SMITH.
HENRY TELFER.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING

HELD IN THE

ROOMS OF THE CHRISTIAN INSTITUTE, GLASGOW,

26th MAY, 1887.

JAMES S. DIXON, Esq., President, in the Chair.

About 30 members were present.

The Minutes of the Annual Meeting were read by the Secretary and confirmed.

The following were elected by ballot as Ordinary Members :—

JEREMIAH CRAMPTON, Union Gold Mining Coy., Limited, Barberton, Transvaal.
JAMES BLACKWOOD, Hamilton Estates Office, Hamilton.
P. B. RUSSELL, Newfield House, Hamilton.
JAMES R. BENSON, West Longrigg Colliery, Slamannan.
JAMES BROWN, Bog Colliery, Larkhall.
ROBERT MUIR, Bog Colliery, Larkhall.
WILLIAM FERGUSON, Eglinton Iron Works, Kilwinning.
PETER S. HAGGIE, Gateshead-on-Tyne.
WALLACE THORNEYCROFT, Jettenhall, Wolverhampton.
WILLIAM REID, Ellismuir Colliery, Baillieston.
JOHN BUCHANAN, Mossband Colliery, Motherwell.
DAVID THOMSON, Craigderran House, Lochgelly.
JAMES HOGG, Rochsoles Colliery, Airdrie.

The following discussion then took place :—

DISCUSSION OF MR GEORGE W. SMITH'S PAPER ON "A MINING TOUR THROUGH SOUTH AFRICA."

MR ROBERT BEITH and other members remarked on the difficulty of understanding, from the short description given, the method of working out the blue in the diamond mines.

The PRESIDENT said this had been fully described in a former paper by Mr Smith, in which he had suggested working with an artificial roof.

Mr HASTIE—They are simply working with a false roof occasionally.

The SECRETARY read extracts from the "Times of Natal" as to the resources of the Transvaal gold fields and the present modes of working, which clearly corroborated the statements and opinions of the author of the paper.

On the motion of the PRESIDENT, a hearty vote of thanks was given to Mr Smith for his paper, and a suggestion by Mr HASTIE that he should be asked to contribute a paper on the South African coalfields was highly approved of.

DISCUSSION OF THE REPORT OF THE SAFETY LAMP COMMITTEE.

The PRESIDENT, in introducing this discussion, said he observed that each member of committee had reported his individual observations. It might be very useful to have some of these experiments.

Mr JAMES ANDERSON—Would it not be possible to print them?

The SECRETARY said every separate opinion was embodied in the subject matter of the report. Each member of committee having written a short report, it was felt that there was a great deal of repetition, because they were almost unanimous in their conclusions.

Mr JAMES ANDERSON said the committee did not state why they recommended the Mueseler.

Mr HASTIE thought the whole world knew that the Scotch gauze lamp was the most expensive safety lamp.

Mr JAMES ANDERSON asked if there was nothing in the experiments that would interest them.

The SECRETARY said there were no details of experiments given, nor of the committee's reasons for their conclusions.

Mr BEITH said the remit to the committee was not to make a hard test so as to prove the practical qualities of the lamps, because that was already fully demonstrated by the Royal Commissioners; it was simply to secure the best substitute for the Scotch gauze lamp.

Mr JAMES ANDERSON said he was led to believe that the results of those experiments went so far to throw discredit on the Commissioners' recommendation.

Mr BEITH asked if Mr Anderson referred to the expression of opinion by the committee that the lamps got so hot it was impossible to operate the shut-off appliances.

Mr JAMES ANDERSON asked if it was the case the gas continues to burn inside, and that it is impossible to use the shut-off.

Mr BEITH—That is so. Sometimes the shut-off got so hot that they could not use it.

Mr JAMES ANDERSON—It is a very important fact and should be brought out.

Mr GILCHRIST—It is stated in the report. One of the experiments,—in fact, the principal experiment,—was to test that. The lamps were put under cover, and the gas turned on. The box in which the lamp was put was a small one, so that in a few seconds the flame shewed that gas was present. After the flame went out the gas continued to burn under the shield for ten minutes, and unless they had paid particular attention they would not have noticed it. That was the reason it was considered dangerous. Of course, had the lamp been burning in a strong current of air, it might have been different.

The PRESIDENT said as he understood, the committee found the gas burned after the flame was extinguished on the wick. It burned for ten minutes, and the lamp required to be lifted up to

see it. That being so, the lamp got so hot, the shut-off arrangement could not be touched. This was a very valuable fact, and, he thought, one that was not noticed by the Commissioners.

Mr JAMES ANDERSON said that was his reason for making the remark. He thought a fact of that kind could not be too strongly brought out. He thought it would have been better if those experiments had been given in the report.

Mr BEITH said it must be kept in mind that some shuts-off were at the top and some at the bottom.

The PRESIDENT—You found those at the top were not practicable.

The SECRETARY said this fact also got prominence in the report.

Mr ANDERSON—But unless you know the other facts, you do not know its significance.

Mr GILCHRIST said the particulars would be found at the bottom of p. 45.

Mr STAFFORD asked what was meant by "combination oil."

Mr HASTIE—It is the mixture of the two oils.

Mr BEITH—The mixture of colza and petroleum oils.

Mr RALPH MOORE—Or spirit. He thought the Royal Commissioners said they found the combination oil to give a better light.

Mr BEITH—They recommend it.

The PRESIDENT said many of the remarks of the Commissioners were taken up with the danger of fire by using the spirit, not in the pit, but in the lamp-room. He did not think that a matter of serious moment because, if a lamp-room were burned, it was merely a loss of property to the owner. Of course, they might refer to a lamp-room underground, which should be avoided. The Protector Mueseler having a sponge that absorbed the spirit did away with the danger of the spirit taking fire and exploding in the lamp.

Mr STAFFORD said he had seen it fired half a dozen yards away.

The PRESIDENT—That is not the principal thing. It is the danger to human life.

Mr RALPH MOORE—If you use a sponge you get rid of that difficulty.

Mr BEITH said at Clyde Coal Coy.'s Colliery they had used the Protector Mueseler lamps for eight or nine years, and during the whole of that time they had never had a fire in the lamp-cabin, which was on the surface. It was simply a matter of arrangement to keep the cabin in order, and so prevent fire from taking place.

Mr RALPH MOORE said he thought now-a-days no one would think of having a lamp-cabin for trimming lamps underground. He thought they had got rid of that. It was a very improper arrangement.

Mr BEITH said when they introduced the Protector Mueseler lamp at first the men were very much prejudiced against it, but now they would have nothing else.

Mr STEWART, with reference to the gas burning inside the lamp, asked what were the final results. Was it allowed to burn until it went out?

Mr BEITH—After it burned for ten minutes, the gas was shut off.

Mr STEWART—If it had been allowed to burn on, would it have exploded?

Mr BEITH suspected it would have burned on.

Mr JAMES ANDERSON asked if it would have burned to such an extent as to have rendered the lamp useless.

Mr GILCHRIST thought it would.

Mr WILLIAM WILLIAMSON asked how the experiments were made, and expressed a doubt as to the gas in the box in which the lamp was kept burning being a proper explosive mixture.

Mr BEITH said the Committee did not intend to go into the actual details as to how the lamp would behave in gas. As previously mentioned, that had already been carefully gone into by the Commissioners.

Mr WILLIAMSON asked if the Committee was prepared to say if the lamp had been put into a proper explosive mixture at its greatest explosive point, that the gas would have continued to burn inside the gauze.

Mr RALPH MOORE said he had seen a very curious experiment with a safety lamp in the gauze of which a hole one eighth of an inch had been made near the top. The lamp was put into a

reservoir of gas, and did not explode the gas. Neither did it do so when the hole was an inch further down, but whenever the hole was made at the level of the light, then it went off. It was a curious fact, of which he had acquainted the Commissioners; but it was after their report was issued.

Mr GILCHRIST, in reference to Mr Williamson's question as to the gas being at the explosive point, said in all the lamps the gas exploded, and in some there was a regular series of explosions. In one or two cases the gas burning inside the lamp came back and kindled the wick.

Mr HASTIE said he thought the Protector lamp was the best for going out when it exploded.

Mr FAULDS, reverting to the subject of the lamps getting too hot for the shut-off appliances being used, asked if this was due to the lamps being experimented upon in a stagnant atmosphere, or could this shut-off appliance be used in a current of air?

Mr BEITH—It will be the same in a high velocity.

The discussion was adjourned.

MR PITKIN'S ELECTRIC LAMP.

MR RALPH MOORE asked what had been done with the incandescent lamp? Had any experiments been made as to the duration of the light.

Mr GILCHRIST said he had some of these lamps at Earnock, and possibly should have brought them before the committee, but the arrangements they had for charging them he thought were defective.

Mr RALPH MOORE—But when it was charged had you any test?

Mr GILCHRIST—We never could get them charged to last a full shift, and did not try them underground.

Mr RALPH MOORE—After they came from the maker?

Mr GILCHRIST said the first one got gave light eight hours, when the lamp gave way. After that they were charged at Earnock, but the dynamo for charging them was not a good one for that kind of work, and he was of opinion that they were not

properly charged. On several occasions the lamps burned from three to five hours. One of them gave light for the same number of hours for which they had charged it, and he thought that was just what Mr Pitkin claimed for it.

The SECRETARY said he understood Mr Reid indicated a doubt as to whether the Earnock dynamo would charge the lamp.

Mr MOORE said it would be a great thing if they could have some experiments and could put the lamp into the maker's hands, telling him their difficulty. If they got a lamp of that kind to last ten hours which could be easily charged and not at a great cost—that would be the lamp. It would be well that they told the inventor of the difficulties they had. If he remembered right, Mr Gilchrist had a great deal of trouble with the electric lights at the Earnock pit bottom before they got them started.

The SECRETARY suggested that perhaps Mr Pitkin would be willing to send a dynamo for charging the lamps.

Mr GILCHRIST said he would communicate with him.

Mr ROWAN said he was in communication with the Edison-Swan Electric Light Company with a view to getting some of Mr Swan's miners' electric lamps for trial in Scotch collieries. He did not wish the members to think that the question of the best electric lamp for miners was exhausted by trials of the Pitkin lamp. Mr Swan had devoted a great deal of time working out the miners' lamp, and had also fitted fire-damp indicators worked by electric currents on the outside of his lamps. He had made lamps worked by both primary and by secondary batteries. The Pitkin lamp made use of a modification of the Faure-Sellon-Volckmar accumulator, in which Mr Swan was interested, and it was open to ques- whether the Pitkin lamp, if successful, could be worked clear of claims upon its battery and its incandescent lamp. So that it was important for the Institute to have before it examples of the incandescent lamp as a miners' lamp about the possibility of obtaining which for use there could be no doubt.

The following paper on "The Schiele Colliery Ventilator" was then read by the Secretary :—

THE SCHIELE COLLIERY VENTILATOR.

By JOHN CHRIGHTON.

THE Schiele fans are efficient machines for the mechanical ventilation of mines, either by blowing or exhausting; besides which they also possess several advantages in respect of economy in cost and compactness of arrangement. Economy of cost in erection is secured by the masonry and buildings in and around the ventilator being slight, as compared with the more costly erections needed for the larger types of ventilators.

To insure rigidity and compactness, the moving parts of the fan (these are the blades and disc) are constructed in solid wrought-iron in one rigid piece, secured by heavy bosses on a massive scrap-iron shaft, which runs in long brass bearings at each side. The rings surrounding the vanes are made to suit the particular taper of the blades, and are in heavy cast iron. The outside casing of the fan is in wrought iron boiler work, and is of volute form, gradually extending in size from the point where the air first enters to the "exit" or mouth of the fan. This volute chamber is of great service in preventing shocks or backlash. The peculiar form of construction enables the air to be carried freely forward as it is given off from the blades, and it acts as a sort of cushion for the air. The special character of the construction of these machines, combined with the high quality of material and workmanship which are always bestowed upon them, insures such perfection in running that the wear and tear is said to be reduced to a minimum.

The air enters the fan in equal quantities at both sides, thus keeping the moving parts in proper balance. The design of the machine is simple, and every part has a sufficient margin of strength to be safely run up to double its normal working speed if required.

These fans are usually driven by a specially designed horizontal engine, fitted with an improved variable expansion motion for the economical use of steam, and carefully balanced. The connection between engine and fan is made by means of leather belting specially manufactured for the very important work it is required to perform. The advantages of driving a colliery ventilator by

belt are now generally admitted, and success has attended the adoption of this method. Belt driving prevents the transmission of shocks between engine and fan, and allows the fan to run with steadiness. As now constructed, the Schiele fans are as practically non-vibrating as any mechanical contrivance can be made. The useful effect given off by this ventilator ranges as high as 65 per cent.

There are about 400 arrangements at work on the various coalfields of Great Britain and abroad, producing quantities of from 20,000 up to 350,000 cubic feet of air per minute, and all sizes can be seen in actual work. The drawings (see Plate II.) shew an elevation and a section of one of these patent Schiele fans, which is in course of erection for the Dowlais Iron Co., South Wales, with the most recent improvements thereon, and which is capable of producing a quantity of 350,000 cubic feet of air per minute, with a water-gauge of from 2 in. to 3 in. This fan is 15 ft. in diameter, and the engines are a pair of 32 in. cylinders with 36 in. stroke; each engine is fitted with a complete set of valve motion and variable expansion cut-off. The fan and engine are connected by a 42 in. wide leather belt, running on a 20 ft. diameter driving fly-wheel on engine 44 in. wide, and a 6 ft. 4 in. pulley on fan 44 in. wide. Both the fly-wheel and pulley are turned on face. There has just been completed at the Altofts Colliery (where the explosion took place some few months ago) an arrangement of the same size as at the Dowlais Iron Co.'s works.

The patentees have fans which have now been running for 16 years, day and night, without cessation, and without accident or any need of repairs. The following are some experiments taken on a few of the fans of different sizes working in various parts of the country:—

RESULTS OF EXPERIMENTS.

Appersknowe Pit, Unstone Colliery, near Sheffield.

(1.) 7 ft. diameter fan, running at 530 revolutions per minute, produced a quantity of 98,700 cubic feet of air per minute, with a water gauge of over 7 in. (all the water being drawn out of the gauge); speed of engine, 122 revolutions.

Rainford Coal Co., St. Helen's, Lancashire.

(2.) 7 ft. diameter fan, running at 337 revolutions per minute, produced a quantity of 102,375 cubic feet of air, at 2 in. water gauge. Engine—16 in. diameter cylinder, 24 in. stroke; speed, 95.

Harris' Navigation Colliery, Quakers' Yard, Pontypridd.

(3.) 14 ft. 3 in. fan, at 159 revolutions; quantity, 314,482 cubic feet of air per minute; engine, 60 revolutions.

Clydach Vale Colliery, Rhondda Valley.

(4.) 14 ft. 3 in. fan, at 208 revolutions; quantity, 323,210 cubic feet per minute; water gauge, 4-6 in.; speed of engine, 77 revolutions; 27 in. cylinder.

John Brown & Co., Limited, Rotherham.

(5.) 13 ft. 6 in. fan, driven by 22 in. cylinder engine, has produced 240,000 cubic feet of air, with 2-4 in. water gauge.

To shew the stability of this fan, its construction making it a machine which can resist heavy shocks, the effects of the explosion at the National Colliery in South Wales on one of them in March of this year may be referred to. The effect of the explosion was such that the great pressure of air passing through the fan at the time of the explosion caused the engine to reduce its velocity seven revolutions, and at the same time every bearing on both fan and engine became almost red-hot. After the explosion had passed through the fan, the engine gradually worked itself up to its normal condition, the bearings cooled down, and no damage whatever was done to the machine. In either the single entry Guibal fan or the Waddle, the damage would have been very great in a case like this, as the pressure is all on one side. In the Schiele fan the pressure is equal on both sides.

The patentees have also an arrangement for helping large ventilators or furnaces and in headings a long way in from the shaft, consisting of a small Schiele fan, driven by either compressed air, steam, or electricity, and which is working to very

great advantage. These fans are also used for forcing air into boiler furnaces, so that smudge and duff coal can be used in place of large coal.

In conclusion, the writer hopes that the information herein given with reference to the Schiele blowing and exhausting fans may be of service to the Institute, and he trusts that the discussion on this subject may elicit valuable information as to the best type of a machine for colliery ventilation.

DISCUSSION.

The PRESIDENT said from other information which he had received he understood this fan was a good generator, and it was at work in the district at Rosehall Colliery.

Mr RALPH MOORE said he had studied the Schiele fan a good deal. Of course, in any fan, it was the speed of the periphery that caused the power. His own feeling was that a fan of a large diameter was more to be relied on than one running like the blower of a blacksmith's forge. Still, he knew that at Rosehall Colliery, where they had two fitted up in duplicate, this fan had been running for a great many years and giving great satisfaction. It did not matter what fan they had if their air courses were not good.

The discussion was adjourned.

THE MINES BILL.

THE PRESIDENT, in answer to a question by Mr Robert Waddell in reference to the Mines Bill, said the Mining Association of Great Britain had adopted most of their suggestions, and the report had been sent to every member of the House of Commons.

Mr JAMES ANDERSON asked if the committee was discharged because the Bill was published with all the amendments, and there were some very extraordinary ones.

Mr RALPH MOORE said the Mining Institute had nothing to do with any Mining Association. They should send their papers direct to the Home Office as coming from the Institute. They did not oppose the Bill; they merely showed, as a Mining Institute, that they were of opinion that certain things would be desirable in the interests of safety. The Mining Association was an association of masters. They, on the other hand, were there speaking as engineers—as practical men; and it was very wrong sending any of their papers to the Mining Association. He could not as a member of this Institute sanction such a thing.

The PRESIDENT said Mr Moore had taken him up wrong. In looking over the amendments that were being supported by the Mining Association, he noticed that virtually what the Institute recommended was adopted, but not as coming from them at all.

The SECRETARY said the Institute had not authorised any one to go and represent it at the Mining Association. They had sent their communication to the members of Parliament, and in his opinion that was all they should do.

Mr JAMES ANDERSON said beyond that he thought the Committee should meet and consider some of the proposed amendments. He thought a meeting might be called to consider them.

The PRESIDENT thought that would be entering into a controversy with the miners, and that was not a position this Institute should take up. They were a scientific body, and they did not support the masters' or any interest. They pointed out what was required for safety and the good of all concerned from a scientific point of view. They had done so, and it was not for them to find fault as miners or as coalmasters.

Mr JAMES ANDERSON said some of the proposed amendments were not in the direction of safety but the opposite.

Mr RALPH MOORE said he had a good deal of sympathy with the feelings of the President. They had had the Bill before them and carefully considered it, and with that he thought they should be satisfied. If they got into a controversy, they did not know where they were to end.

The SECRETARY thought they should guard against its being considered that they acted in the interest of either the coalmasters or coalminers.

Mr JAMES ANDERSON said some of the amendments proposed were in the way of annulling what they had proposed. He thought the Institute was to be congratulated on what they had already done.

The SECRETARY—At the same time, I do not think it is for us to enter into a discussion on the Bill in Parliament.

Mr ROBERT WADDELL remarked that there were several points on which they might individually communicate with their own Members of Parliament.

This ended the discussion, and the meeting adjourned.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON,

14th JULY, 1887.

JAMES S. DIXON, Esq., President, in the Chair.

Fully 30 members were present.

The Minutes of the former Meeting were read by the Secretary and confirmed.

The following were elected by ballot as Ordinary Members :—

HUGH SWANN, Polknave, Bothkennar, Falkirk.
RICHARD ROBERTSON, Newarthill, Motherwell.
ROBERT WATT, Silvertonhill Colliery, Hamilton.
WILLIAM DAVIS, Barncluith Colliery, Hamilton.
DANIEL SMITH, Kirk Street, Wishaw.
WILLIAM FREW, Quarter Colliery, Hamilton.
WILLIAM PARKER, Crosshill, Baillieston.
DUGALD STEVENSON, Clydeside Colliery, Uddingston.
ANDREW RUSSELL, Dykehead, Shotts.
WILLIAM CRAIG, Main Street, Coatbridge.
WILLIAM CAIRNS, Muiredge Colliery, Buckhaven.
FRED. W. PAUL, Hallside Steel Works, Newton.
JAMES SHEARER, Mountcow Colliery, Salsburgh, by Holytown.
HENRY KING, Blair Bridge, Coatbridge.
JAMES CALDWELL, Pumpherston Oil Works, Mid Calder.

The following discussions then took place :—

DISCUSSION OF THE REPORT OF THE SAFETY LAMP COMMITTEE.

Mr DAVID DUNN said he understood from the report that the Committee recommended one kind of lamp and a particular oil for coal and stone miners, and a different lamp and oil for shiftmen, but they did not give any reason why they made this distinction; and he thought that it would be satisfactory to know the reason.

The PRESIDENT—You refer to the one burning naphtha and the other combination oil?

Mr DUNN—Yes. He might say, in reading over this report, it was quite clear that there was a strong leaning to the Scotch gauze lamp, and it would be interesting to know if the Committee were unanimous in this. The Committee had made individual reports, which was a very proper way of proceeding, but in laying the matter before the Institute he thought they should have agreed upon a report, stating precisely what lamp they would recommend to be used. They must have known that this Scotch gauze lamp was likely to be prohibited. The Inspectors objected to it, and had done so for some time, and the Commissioners on Accidents in Mines also objected to it; and, he thought, it would be bringing the subject to a conclusion if the Committee had agreed upon a report, and if that report had recommended a lamp as a substitute for the Scotch gauze. They knew that in England Davy lamps were in pretty general use, and if they went into an English mine they found it hanging up and the men working away; but the Scotch miner had not yet got into the way of hanging his lamp on a tree behind him when at work. The Committee, after certain experiments, put the lamps into the hands of firemen and others, and they expressed certain conclusions from the experience of these firemen, but they did not point out, in any one case, what their experiences were. For instance, they did not tell them the nature of the tests that the lamps were subjected to in the pit—such as, the greatest explosive current they were put into, or how long they burned without trimming, and if they gave

a satisfactory light up to that point: also, what proportion of gas and air the lamp was subjected to when it got so readily hot. As to the kinds of oil, it had been proved from time immemorial that good seal oil was the best they could get for lamps, and that was mentioned by the Royal Commissioners as being the result of their experiments, and he thought the Committee in their report should give reasons for their views.

Mr GILCHRIST explained that Mr Beith, convener of Committee, was unable to be present, or possibly he might have been able to have replied more fully than he could. He drew attention to what the Committee said, near the bottom of p. 45, as shewing the conditions under which the lamps were tested. As to the miners in England hanging up their lamps, he was astonished that Mr Dunn should not know that the miners here hung up their lamps also. Ever since the better class of lamps had been introduced, the men did not work with them in their belt. They were hung up or placed in a safe position from the pick. He also said that there was nothing said about the currents in which the lamps were carried while the workmen were using them. They were carried about in air currents varying from 200 to 1200 feet per minute, but he would be very much surprised to hear that in any of the collieries in which they were tried there were any explosive currents. (Hear, hear.) He had never seen an explosive current in any of the collieries in this district. (Hear, hear.) Mr Dunn also wanted to know the reason for recommending different oils. One reason he had already mentioned, viz.—the colliers hanging up their lamps. Owing to them being able to hang them up, the lamp was not so liable to go out, and it gave, of course, a very good light, but when the drawers and oncost men were going about, and had sometimes to place their lamp at a disadvantage, and especially where there was a great deal of snibbling going on, the lamp had to be hung in a belt, and in some cases,—he did not say in every one,—it had been found a lamp burning spirit went out more readily, whereas a lamp burning colza or combination oil did not go out so easily. That was the reason for the Committee's recommendation. Mr Dunn had asked also something about the Scotch gauze lamps——

Mr DUNN (interruping) said, considering there were no explosive currents, Scotch gauze lamps might be used in all the mines in Scotland, and particularly in those of this district.

Mr HASTIE said it depended on the currents.

Mr GILCHRIST said the Committee were of opinion that the Scotch gauze lamps had done good service, but where the air currents are strong, a much better lamp is required. They were aware of the fact that it had been used for a great many years, and so far as they knew no accident had ever been traced to it. That was one reason why they thought it had done good service and might still do good service in some collieries. Also, the lightness of the lamp was in its favour, but there was this objection : it could be easily tampered with ; and that was a very strong objection and one he did not think the Committee could get over. There was another important point Mr Dunn had omitted. In a report by a Committee on the Scotch gauze lamp in 1882, it was brought out that the cost of keeping 100 Scotch gauze lamps for 300 working days was at one colliery £157 14s 2d, and at another, £157 10s, or an average of about £1 11s 6d each, while the same number of Mueseler Protector lamps burning naphtha could be upheld for £40, or at a cost of 8s per lamp per year. He thought that fact had evidently been overlooked for a considerable time, or they would have had fewer Scotch gauze lamps in use.

Mr DUNN said, with regard to the cost, he had not had much more than ten years' experience of Davy lamps, and there was a separate account kept of the upkeep, but it fell immensely short of what had been stated by Mr Gilchrist. As to tampering with the Scotch gauze lamp, he had not yet seen a lamp that could not be tampered with.

Mr DAVID ANDERSON—There is one—the Mueseler Protector —that cannot be tampered with, and there are hundreds in use at some collieries.

Mr GILCHRIST said that was acknowledged to be one of its great advantages.

Mr DUNN—Can't it be unscrewed ?

Mr GILCHRIST—Not without putting out the light.

Mr DAVID ANDERSON said he thought Mr Dunn's remarks had

served a good purpose. They had brought out a fuller explanation than was given in the Committee's report. But there was an element which ranked even before cost with them. They began with safety first and economy afterwards. As to the Protector lamp, it could not be opened, and if a strong blower of gas came out, the light was extinguished almost immediately. As to the return currents not being heavily loaded with gas, and consequently so safe that they might be used with a Scotch Gauze lamp or open light, it was the unexpected that happened. Those currents, in ordinary cases, might be perfectly safe, but accidents took place, and if there was a sudden outburst, it might overpower any ventilation. There were currents in the Hamilton district which, according to the report of the Accidents Commission, would cause the flame to pass through either the Scotch gauze lamp or the Davy. They had demonstrated that in a current of somewhere about 6 feet per second both of these lamps were dangerous. Well, there were currents in the Hamilton district that exceeded 6 feet. This Protector lamp was absolutely safe in almost any current. It was well it should be known that the Marsaut lamp, with double gauze and burning spirit, did not go so readily out as the Mueseler Protector. That was what the Committee meant. Still there were collieries where the Protector lamp was in use wholly and entirely except for the purpose of the fireman making his examination. The reason they were not then used was that they were far more sensitive and easily put out than the Davy was among gas. If they got gas with a Protector lamp, they needed to be very cautious. Much more time had to be spent with it in trying for gas. He thought the Protector was a lamp that had done as good service in its time as the Scotch gauze, and he did not know that the Committee indicated a preference for the continued use of the Scotch Gauze. ("No.") It was at any rate a fact that the Scotch gauze lamp was being discarded.

The PRESIDENT said he thought Mr Dunn should take it as an established fact that the Scotch gauze lamp was the most expensive—quite as much so as Mr Gilchrist had spoken to. He had ascertained that for himself, but he had continued to use it until a better lamp was discovered; and that was very much what the

Committee was appointed for. He thought they had thrown a good deal of light on the subject. From recent experience he had found that the Marsaut lamp, burning spirit, was a good one for drawers. Without the shield, it was not so easily extinguished.

Mr DUNN said, in making any remark, his intention was the very opposite of seeking to justify the continued use of the Scotch gauze lamp. His own opinion was that almost any other safety lamp was in many respects better. But those reading this report a few years hence would come to the conclusion that this Committee, as a result of their experiments, had not found a lamp they could recommend as a substitute for the Scotch gauze.

Mr HASTIE said Mr Dunn ought to understand that the Committee were simply appointed to find out a lamp as a substitute for the Scotch gauze as used by the drawers and oncost men—not for all purposes.

The PRESIDENT said they were unanimous as to having a good collier's lamp, but they had not got the best one for drawers; and it was to try and find a lamp for them, in substitution for the gauze lamp, that the Committee was appointed. He thought the very fact that they were all aware that the Scotch gauze lamp was so expensive to keep up, while they still continued to use it, showed there was a difficulty. That difficulty had not been overcome yet; but he thought, as a result of this report, and from what the managers were doing, they were gradually accustoming the men to a superior lamp, and he had no doubt the Scotch gauze lamp would be gradually set aside. The Scotch gauze lamp had been forced upon them simply because the men could not keep a light with the other lamps and do their work.

Mr JOHN HOGG said, since they spoke of a lamp for drawers, probably it had been found that the Protector hanging from a belt was not very convenient for a drawer or driver, especially where they had to snibble. They had either to set their lamp down, or hang it on their belt in a position which was not very convenient. Some little time ago, at North Motherwell Colliery, they got a belt made to pass round the driver or drawer's

shoulder and across his breast, so that it might hang higher on his body. They found this a great improvement and convenience.

Mr J. M. RONALDSON said he thought they were getting into a little confusion regarding the Protector lamp. They ought, in mentioning it, to speak of the Protector Marsaut, the Protector Davy, and so on; because the term "Protector" only applies to the method of constructing the under part of a safety lamp, and the manner in which the illuminant is used.

Mr GILCHRIST—The report mentions the Protector Mueseler or Marsaut.

The PRESIDENT—The "Protector" means only the screw arrangement for extinguishing the light. It does not follow that it is a Marsaut or Mueseler lamp.

Mr ANDERSON said the great point was it was a real protector. It was in the bottom the protection lay: still, the Protector Light Coy. did not consider it necessary to have anything else attached to their prospectus but "Protector."

Mr GILCHRIST, with reference to an assertion that this Protector appliance could be applied to any lamp burning any kind of oil, said he had heard of some lamps with Protector bottoms being made to burn colza oil, but again it was said it could not be done. He asked Mr Anderson if he had any burning colza.

Mr ANDERSON said he was not aware of any of that description; but he knew the Protector bottom was applied to lamps under the popular name of "Protector lamp."

Mr DUNN said, whilst it was, he believed, a Protector lamp in this respect, that any one attempting to open the lamp would put out the light, was it equally a Protector lamp against the men putting a bit of wire through the gauze. They had heard of miners in this neighbourhood putting a piece of wire through the gauze, got it made red hot, and fired a shot with it. Could this lamp be so tampered with?

The TREASURER—Where could you get the wire in?

Mr DUNN—At the top.

Mr ANDERSON—It is impossible.

Mr DUNN—I have never tried.

Mr GILCHRIST—I think the same objection will apply to any lamp with a gauze.

Mr ANDERSON admitted they could break the lamp, but nobody could put in a wire and do as Mr Dunn suggested.

Mr DUNN—We have been reading lately of men getting their pipes lighted in that way.

The TREASURER—Not with that lamp.

Mr DUNN—Can it be done?

Mr GILCHRIST—It has never been tried, and the Committee think it could not be done.

The TREASURER—The man who sits till he gets his wire red hot with that lamp will lose his shift.

Mr HOGG asked if the heat that would make a wire red hot would not burn the gauze out, and was answered in the affirmative.

Mr RONALDSON—The man who is determined to smoke, instead of displaying his ingenuity in doing that, will take a simpler way: he will carry matches in his pocket.

The PRESIDENT, in closing the discussion, said the Committee's Report, and what had been said there, had given an impetus to colliery owners to try and overcome the difficulty of getting a suitable lamp for drawers and oncost men apart from the Scotch gauze lamp. He moved a hearty vote of thanks to the Committee for their Report, which was cordially given.

DISCUSSION OF MR JOHN CHRIGHTON'S PAPER ON "THE SCHIELE COLLIERY VENTILATION."

The SECRETARY drew attention to a slight error in the printing of the paper, p. 58, where, in one instance, the water gauge was said to be 4·6 instead of 4·6, and in another 2-4 instead of 2·4.

Mr A. M. GRANT said this was a very important subject that had been laid before them by Mr Chrighton, but the information that he had given them was of the most meagre description; but the subject was of such importance that he thought it would be well if Mr Chrighton would be willing to answer a few questions which would lead to a discussion of some interest and value to the Institute. He would ask, first, if Mr Chrighton would kindly show them wherein the economy of cost in the erection of masonry and building was greater than in the Waddle or Guibal fans, because the Guibal fan could be built from the foundation below the level of the centre of the crank shaft on iron plates quite as well as the Schiele fan. He should also like to know if the construction of the fan was of the volute description. The contour of the fan to the volute seemed to be a point of great moment in the working of this fan, as it was said to act as a cushion for air. He thought the Guibal fan, from the base or bottom into the chimney, was also built of the volute, and that contour outside of the Schiele fan was simply a continuation of the volute up to the top periphery of the fan. Was that not giving the same thing in the Guibal as in the Schiele fan? He also made a point of the air entering the fan in equal quantities at both sides, but it was well known that that was done every day with the Guibal fan. The writer said the design was simple and every part had a sufficient margin of strength. This was also the case with the Waddle and Guibal fans, if properly designed and constructed, and it was hoped all fans working were so. He said the fans were driven by a specially designed horizontal engine. He should like to know wherein the speciality consisted. He should also like to know what was special about the leather belting. It was said "the advantages of driving a colliery ventilator by belt are now generally admitted." He (the speaker) did not admit that, and a great many others did not admit it. He should like

to know if there was any slip between the engine and the belt. As to the fan being fifteen feet in diameter, he held that a Guibal or Waddle fan of equal capacity would be driven by a much smaller engine. He should like very much if Mr Chrighton would produce the diagrams of his engine so that they might compare them with those of another fan of equal capacity. The belt that drove the fan was thirty-two inches wide, and he thought, no matter how "specially" constructed, it would cost nearly as much as an ordinary Guibal fan did. He gave the result of an explosion on the fan in a colliery in South Wales, and said in any other fan the damage would have been very great as the pressure was on one side; but a Guibal fan was not necessarily a single entry fan—it could be made double. The writer hoped the paper would elicit valuable information. He (the speaker) thought if his questions were answered there would be something to discuss, but in the meantime there was really nothing to discuss.

Mr GILCHRIST said Mr Beith would like Mr Chrighton to compare the results of the forcing and exhausting fans, giving water gauge, &c., and state if the makers have both systems working in connection with one mine.

Mr GRANT said there were two Schiele fans at Rosehall Colliery. He understood these were the only ones in Scotland, but now found there was another at Lugar. He should like to know the result with these and other fans, if any.

Mr M'LAREN—There is one also in Fife.

Mr RONALDSON—There are several throughout the country. He had just received the following letter from Mr J. A. Clarke, Ayr Colliery, as to experiments with a Schiele fan:—"The fan is 9 ft. 6 in. in diameter, and is driven by a belt 18 in. broad, passing over a pulley 3 ft. 6 in. diameter on the fan shaft, and the driving wheel 10 ft. in diameter on the engine shaft; the engine cylinder is 18 in. in diameter, and the stroke is 2 ft. We directed our attention chiefly to testing the manometric efficiency,—that is the proportion which the observed W.G. bears to the theoretical W.G.,—and only made one measurement of the volume of air passing at the highest speed, viz., 90 revolutions of the engine, or 257 revolutions of the fan,

when we found that there was a volume of 100,137 cubic feet per minute, with a W.G. of 2·55 inches. In order to test the absolute manometric efficiency, we put up a partition in the fan drift so as to cut off communication with the outside air; and from the trials made at different speeds, which also agree with others which were formerly carefully made, we find that the average absolute manometric efficiency is only 47%, and that when the fan is drawing through the pit it drops until it is only 35%. From similar trials made with a 30 ft. Guibal fan, we found that the manometric efficiency, when the air was cut off, was 63½%, and when the air was passing through the pit, 62%. In this respect—that is as to its power of producing a high water gauge relatively to the blade tip speed—the Schiele fan, at least our one, seems to be very inferior to the Guibal; and under ordinary working conditions the evil seems to be accentuated, as then the proportion for the Guibal being 62%, that for the Schiele is only 35%. We think this is partly due to the friction on the passage of the air through the comparatively small openings of the fan." Some years ago details appeared in the Transactions of experiments made with a fan 5 ft. 3 in. in diameter, when it was found that the percentage of work in the air current, as compared with the total work of the engine, was 21·73, and the manometric efficiency was only ·1. He thought these small Schiele fans could not possibly be very efficient, simply because of the small area through which the air passed, and, as Mr Moore very aptly remarked at last meeting, there was far more in the airways than in the fans. Referring to the experiments in the paper, Mr Ronaldson said they simply shewed that the air-courses were far better in one pit than in the other; and either a Schiele, Guibal, or Waddle fan would do very good work, provided it got a fair chance below ground.

Mr DUNN, also referring to the experiments in the paper, said it would be interesting to have the water gauge. He quite sympathised with what had been said as to the want of information in the paper with regard to the cost and other arrangements. He had fitted up several fans—two of the Guibal pattern and one Waddle—but never a Schiele, because he would not fit up a Schiele to ventilate a mine on any account. It was a fast running

fan, and therefore objectionable. The best ventilation he had witnessed was from a Guibal fan, 30ft. in diameter, going at 30 revolutions per minute, and the reason was that they had air-courses with an area of 57 feet.

Mr ANDERSON asked how much air was produced.

Mr DUNN said he could not give the figures just at present.

Mr ANDERSON—I think it is a pity, because I think it would have produced a velocity that would have put the lights out.

Mr DUNN said the workings were not of large area, but the low speed of the fan was the remarkable point for the ventilation they had.

The PRESIDENT quite agreed with all that had been said of the paper. It was very crude indeed, and the information contained in it was of little value to them as an Institute. To show distinctly the superiority of such a fan required an amount of elaborate experiments and calculations gone carefully into to show the manometric efficiency of the fan. He hoped the author, who was presumed to know the fan both practically and theoretically, would supply them with that after he had read what had been said that night.

Mr GILCHRIST said the experiments seemed to show the larger the fan the better the results, and it would naturally be a point in buying one, whether the purchaser would not get a large Schiele fan and run it slowly. We might then come to the conclusion that the Guibal was the best.

The discussion was adjourned.

The following paper "On Exploring the Workings of a Mine after a serious Explosion" was read by Mr John Hogg:—

ON EXPLORING THE WORKINGS OF A MINE AFTER A SERIOUS EXPLOSION.

By JOHN HOGG, North Motherwell Colliery.

THE writer trusts that serious explosions in mines are things of the past; yet, while doing all in our power to prevent the recurrence of such a calamity, we should also be prepared to meet it; and with a view to help in this direction, the following observations have been written.

In those who—though familiar with mines and mining—have never helped to restore the ventilation and make a way into the working places of a seam after a blast, there is that feeling of mystery and dread which more or less attaches to the unknown. This feeling, the writer hopes, in some measure, at least, to remove, and will try to follow step by step what is done by explorers.

The shafts and ventilating machinery will claim the first attention of those on the surface, and an effort will be made to reach the pit bottom as expeditiously as possible. Assistance from the neighbouring collieries will also be requested, and soon there will be no lack of willing helpers.

Should the shaft need repairs before communication between top and bottom is restored, the person in charge on the surface will in the meantime see that props of the length in ordinary use, brattice wood, cloth, and nails are brought to a convenient place for putting on the cage; and he ought also to collect all the graith likely to be required, such as axes, saws, and hammers. It is important, also, that rough tracings of the workings be prepared for the use of every leader of a squad of explorers. Managers will understand how useful this must be to those who are penetrating into workings about which every man of his squad may have been heretofore quite ignorant.

Let it be supposed that the explorers have arrived at the pit bottom, and are ready to proceed. I would suggest that for each section, if more than one is operated upon, there should be two managers, each having his own squad of men and his own particular duty to do. One may take charge of restoring the ventilation, the inspection of the workings, and the clearing of

the roads; the other may appoint and have charge of the bottomer, the conveying of material, and the detailing of stretcher companies where required. They can consult and help each other in every difficulty; but system is necessary if the work is to be done in the shortest possible time.

The manager who has charge of the men in front now appoints two men with good nerves to act as firemen, instructing them to inspect and report to him the condition of the workings within a short radius. He then forms the rest of his men into, say, three squads of three in each, who will work together at stoppings or falls until separated by him or until the end of the shift. Being near the pit bottom, it will probably be found that all is clear for three or four stoop lengths, and stoppings are now begun to be put up. But material will be required for this, and when the cage is first sent to the hill for the same, it would be well that the person in charge do not try how much he can send down in one load, but that he will with all despatch send down say half-a-dozen each of trees and brattice boards, with one piece of cloth and nails. This will allow a start to be made, and prevent a number of anxious men from fretting over, to them, unaccountable delay. Larger loads can be sent down in after runs. For convenience in carrying, the cloth may be cut into lengths to suit the drifts, with two or three feet to spare. Squad No. 1 is detailed to the first stopping. This may be put up with boards top and bottom and cloth between. But if the air current is strong, a few of the following stoppings may be put up by squads two and three, with cloth only stretched between two trees. These will be very quickly put up, and will drive the ventilation forward, allowing the firemen to extend rapidly the area of inspection. These stoppings can be completed by No. 1 squad. Soon it will be impossible thus to proceed. The foulness will in all probability become more difficult to dislodge, and eventually one squad may be able to put up the stoppings as quickly as the fire or choke damp can be carried off. Part of what we may call the ventilating party can now be transferred to the bearer company, the duties of the latter having become heavier as the stoppings advanced. It is not an easy task to carry trees long distances in a stooping posture, and

when to that is added, it may be, the carrying out of living or dead bodies, the men begin to fag very soon. But the person in charge here must see that the forward party are kept in material for stoppings so that no delay may occur on that account. A system of staging gives relief to the carrying parties.

To conclude with a few general remarks. Let those who have never yet assisted to explore a mine after an explosion, be assured of this that the chief requisites in a leader are a capacity for hard work, and the ability to organise his men into a system, however roughly, whereby work will be best forwarded. It will not speed the work to say to a dozen or more men generally do this or that; neither is it beneficial to allow all the workmen to discuss matters and suggest plans. Those in charge ought to arrange what is to be done. Anything else results in noise and confusion. And let men who are sent from other collieries take with them their own tools and lamps. Those in charge ought to take note of the position, &c., of bodies found, and of every point which is likely to throw light on the cause or origin of the explosion. This can be more correctly done before the roads are disturbed by dust and travel. These notes might not only be the means of ascertaining the cause of explosion, but also of pointing out a way of prevention in the future.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON,

25th August, 1887.

JAMES SMART, Esq., Vice-President, in the Chair.

About 20 members were present.

The minutes of the former meeting were read by the Secretary and confirmed.

The following were elected by ballot as ordinary members:—

JAMES BROWN, Silvertonhill Colliery, Hamilton.
JAMES ANDERSON, Wishaw Iron Works, Wishaw.
ROBERT HART, Hillview Cottage, Kirkintilloch.
WILLIAM ADAM, Blantyre Saw Mills, High Blantyre.
JAMES R. THOM, Twechar, Kilsyth.
ALEXANDER FRAME, Larkhall.

The following discussions then took place:—

DISCUSSION OF MR CHRIGHTON'S PAPER ON "THE SCHIELE COLLIERY VENTILATOR."

The SECRETARY read a note from Mr Chrighton, regretting, as he had been from home, that he had not been able to answer the different enquiries raised in last discussion, and promising to forward his reply as soon as possible. Mr Barrowman also read the following communication from

Mr GEO. BLAKE WALKER:—"It may be interesting if I state what success the Schiele fan has met with in Yorkshire, as far as my personal knowledge goes. It is in South Wales where it probably enjoys the greatest popularity, but in Yorkshire by far the greater number of the new fans are of the Schiele type. One of the first to adopt the Schiele was Mr C. E. Rhodes of Aldwarke Main Colliery, who about 1875 put down a 7ft. Schiele on the Swallow Wood Mine at Carhouse Colliery. The results accomplished by this fan were thought at the time to be very good indeed—about 60,000 feet of air was produced at something slightly under 2-inch water-gauge. Since then Mr Rhodes has put up three other Schieles. Two of them are 13ft. 6in. diameter, and equal to 200,000 cubic feet of air per minute. Among the most recent erections of this type is a 13ft. 6in. fan at South Kirkby Colliery, which has as yet not got much to do, the colliery being new, and a 15ft. one at the Altofts Colliery. This colliery prior to the explosion was ventilated by means of a furnace, but this was considered too risky after the accident. The Union Company were asked if they could deliver the fan in a month, and they did so. Mr Garforth, the manager, is greatly pleased with the fan. It has to work under a 4-inch water-gauge on account of the small size of the upcast shaft, but with this heavy friction a quantity of 160,000 feet is obtained at about 200 revolutions. The small 7ft. fan at the Apperknowle Pit of the Unston Coal Company is noticeable as having shewn the highest water-gauge I have yet heard of, 7½ inches. The manager, Mr Hewitt, is quite enthusiastic about this fan. It replaced a Waddle, which was a failure.

With regard to my own experience. We have at Wharncliffe Silkstone Colliery, two Schieles. The first was put down about

seven years ago. It is placed underground. This was done for two reasons: first, because there was a difficulty in finding a suitable site on the surface; and, second, because I fancied the effective *exhaustive* power of the fan would thus be applied to the mine direct, saving the shaft friction, the *propulsive* force of the fan forcing the air up the shaft. I believe there is some advantage gained in this manner, although a certain amount of back pressure is certainly caused by the shaft. This fan is 8ft. dia., and runs about 230 revolutions per minute. The highest quantity obtained at any time was 118,000. Return water-gauge, 1·2in; shaft water-gauge, 0·6in.; total, 1·8in. At present we get less owing to less freedom in the workings. The return water-gauge is 1·9in.; the shaft, 0·5in.; total, 2·4in. Quantity, 85,000. When at the best the useful effect was 62·2 per cent. In February last I started a larger fan. This is 12ft diameter. It is constructed to produce 170,000 cubic feet per minute at 4in. water-gauge. The air has to be derived from two seams, one of which is only just opening out. At 175 revolutions, about 108,000 feet per minute are produced, about 85,000 being from one seam, the air in the other being strictly regulated. The water-gauge is 3½in. to 4in., and we could easily get far more if we wished, as the engine is only running 35 revolutions. The useful effect is about 54 per cent. steam cut off at ⅜ stroke. The useful effect will naturally be better when the fan is running full."

It was agreed to defer the discussion until Mr Chrighton's reply was received.

DISCUSSION OF MR HOGG'S PAPER "ON EXPLORING THE WORKINGS OF A COLLIERY AFTER A SERIOUS EXPLOSION."

The CHAIRMAN said he would be glad to hear any observations on this paper, although Mr Hogg was not present.

Mr GILCHRIST said he thought Mr Hogg had explained very fully what had to be done in the case of a serious explosion. There was one point, in his view, that he had omitted, viz., the appoint-

ment at once of some one to take charge on the surface. At Blantyre, and for a short time at Udston, nothing could be done very well, because no one had full charge. One might be running about doing his best, and some one else doing the same, but it led to confusion. After the Udston Colliery explosion, a number of managers brought forward men who were prepared to go down; and, he believed, owing to the absence of some such arrangement as he suggested, they felt a little annoyed that their services had not been accepted. They could not expect the manager to take such charge, although he was there to give all the assistance he could.

The SECRETARY had no doubt the paper conveyed all that Mr Hogg intended should be conveyed by it, but its title led them to expect more than the paper contained. He thought perhaps it would have been more correct had it been entitled "Exploring the Workings of Udston Colliery after the Explosion," because that was strictly what the paper described.

The CHAIRMAN, referring to Mr Gilchrist's remarks, said he thought the manager was the man to take charge, unless he had lost his head.

Mr GILCHRIST, in case he should be misunderstood, said he did not mean a leader to go into the mine. It was a man on the surface to arrange shifts, send down material and everything of that kind, and see that it was done.

Mr DAVID ANDERSON approved of Mr Gilchrist's suggestion. He thought such an appointment quite necessary.

Mr GILCHRIST said, while they might not get the best man, he saw no difficulty in getting one equal to arranging such details. No doubt the work of danger was the going underground.

The discussion was then adjourned.

The following description of the Annual Summer Excursion of the Institute was submitted by the Secretary and held as read :—

ANNUAL EXCURSION.

THE annual excursion of the Mining Institute of Scotland took place on the 4th, 5th, and 6th August to Newcastle, and was the most successful that the Institute has had, both in respect of numbers and of variety and interesting nature of places visited. The success of the excursion was largely due to the extensive arrangements made by the North of England Institute of Mining and Mechanical Engineers, who had issued invitations to the members of this Institute, as well as of Institutes in England and elsewhere. The party travelled by Caledonian and North Eastern Railways *via* Carlisle to Newcastle, starting on Thursday morning, 4th August. The main contingent left Glasgow Central Station at six o'clock, and were joined at stations on the way by others from Hamilton, Coatbridge, Airdrie, and Edinburgh, until, on reaching Carlisle the number was over 120. A committee of the Council, acting along with a committee of the members resident in Newcastle, had prepared a programme for the members, taking advantage so far as practicable of the arrangements made by the North of England Institute, so that time should be taken up to the best advantage.

On their arrival at Newcastle the members hurried to their respective hotels, where rooms had been previously secured, and had only time to leave their travelling bags and return to the station to get the train for South Shields, where they arrived shortly after mid-day. Through the kindness of one of the members,—Mr P. S. Haggie, of the firm of Haggie Brothers, wire-rope makers, Gateshead-on-Tyne,—lunch was provided in the Royal Hotel, South Shields. The long journey had prepared the party for enjoying this agreeable incident in the day's proceedings, and ample justice was done to the repast; and the toast of the health of Mr Haggie, who presided, was heartily pledged.

It had been arranged to visit three collieries in and near South Shields that day—St. Hilda, Harton, and Boldon. St. Hilda, which is within the town, was first visited. The shaft here is the upcast for Harton Colliery, and is fitted with a Guibal fan, 50 feet in diameter, which is the largest of its kind

in the country. The pithead frame is a fine malleable iron erection. The winding engines have cylinders 36 inches diameter, and the drum is 19 feet diameter. Round steel ropes are used, and the cages are arranged for four decks, with two tubs, end to end, on each deck. The coal is raised from a depth of 115 fathoms. Improvements are being made at the pithead in the erection of additional coal-screening apparatus and plant for the manufacture of patent fuel by Yeadon's system. The tail-rope system of haulage is in operation, the engines being underground and the steam boilers at the surface.

Taking train to Tyne Dock Station, the party next visited Harton Colliery. The winding is done from a depth of 215 fathoms by a single vertical condensing engine, cylinder 65 inches diameter, stroke 7 feet, the drum or pirn for flat steel rope being 26 feet diameter. To counterbalance the weight of the rope in the shaft, a chain with a weight attached, and hanging in a pit behind the engine-house, is wound on the pirn shaft during one-half of the travel of the cage in the shaft, and unwound during the other half. The cage is three-decked, with two tubs to each deck. The tail-rope system of haulage is used, with the engines at the pithead. This colliery and St. Hilda have been working for many years.

A walk of fully a mile, and Boldon Colliery was reached where the party was met by Mr May, the manager, and conducted by him over the works. This is an extensive and modern colliery, and the buildings and machinery are arranged for the handling and disposal of a large output. Here, as in most collieries of the district, the ventilation is produced by a large furnace underground. The coal is raised from a depth of about 270 fathoms, by two pits, about 30 yards apart. The winding engines at No. 1 Pit are high pressure coupled, cylinders 48 inches diameter, 6 feet stroke, with a conical drum 19 to 30 feet diameter. The cage has four decks for eight tubs, each tub containing 12 cwts. of coal. No. 2 Pit engines have cylinders 40 inches diameter, 6 feet stroke, with conical drum 16 feet to 26 feet diameter. . The cage has two decks for four tubs. To facilitate the loading and unloading of the four-decked cages, there are two levels or platforms at both top and bottom of the

shafts. Two decks may thus be loaded or emptied simultaneously. The haulage engines and connected steam boilers are underground. Tail-rope is the system of haulage. A number of the party were conducted underground and examined with much interest an arrangement of hydraulic hoists at the shaft bottom for lifting the tubs of coal from the low level to the high level, and a self-acting device for allowing the empty tubs to run into a lye. These hoists consist of a platform large enough to hold two tubs end to end. This platform is attached by a socket or hinge to the top of a hydraulic ram. When at the low level, the hinge enables the platform to lie at such an inclination that the full tubs self-act on to it. When the water is turned into the hydraulic cylinder, the platform is raised in a horizontal position till it reaches the upper level, when one end is held by a catch. The ram continuing to rise for a short distance, the hinge enables the other end to tilt up sufficiently to cause the tubs to again self-act on to the rails leading to the cage. This ingenious contrivance is required as more loaded tubs arrive at the low level than at the top level. Similar self-acting platforms are fitted into a blind pit, down which coals are dropped from an upper seam. When empty tubs require to be lowered from the upper to the under level, this is done in a shaft fitted with a single cage and a balance weight sufficiently heavy to bring back the cage on the tub being run off.

The use of safety hooks to prevent over-winding is not universal in the district; but King's hooks are fitted at this colliery and some of the others visited.

It was now five o'clock, and the party walked to Brockley Whins Station, and took train to Newcastle, which was reached an hour later. The Exhibition was visited in the evening.

On Friday a number proceeded on a special excursion to Silksworth and Seaham Collieries, and some took advantage of the arrangements made by the North of England Institute for an excursion down the River Tyne, visiting engineering and other works on its banks. About 70 chose the former. Leaving Newcastle at 8.25, Sunderland was reached at 9 o'clock. Here brakes were waiting to convey the party to Silksworth Colliery, a distance of three miles. They received a hearty welcome on

their arrival from Mr Panton, the manager of the colliery, who showed the plans of the workings and conducted the party over the works. When it is stated that the daily output of this colliery is 2300 tons drawn from one shaft by four cages, an idea may be formed of the magnitude of the buildings and fittings. One of the divisions of the winding shaft, which is 270 fathoms in depth, has coupled engines with cylinders 48in. diameter, 6ft. stroke, with cylindrical drum 25ft. in diameter, the cage having four decks with eight hutches, each hutch carrying 10 cwts. of coal. The other division, 290 fathoms in depth, is fitted with engines of similar dimensions, having a scroll drum 15ft. to 28ft. diameter. Six cylindrical and 18 Lancashire boilers provide the necessary steam; and connected with the double-decked heapstead, or pit-head scaffolding, there are thirty-six screens and three revolving screens for separating the small coal. Tail-rope haulage is used, the engine and boilers being underground.

In this colliery, the hewers use the bonneted Mueseler lamp, and the deputies, putters, and drivers use the tin can Davy. In all the collieries visited, the tin can Davy lamp is largely used. Although the light from this lamp is not so good as from the Mueseler and other lamps of similar construction, yet the wire gauze and outer casing afford double protection in case of accident to the lamp in an explosive atmosphere; and on this account the tin can lamp is preferred by some.

On leaving Silksworth three hearty cheers were given to Mr Panton and the colliery officials who had rendered willing service to those who visited the underground workings.

The workmen's houses connected with these collieries are of a superior description. Two storied and having well-stocked garden plots in front neatly railed in, they have an appearance of order and comfort that speaks well for the character and habits of the miners. This colliery, as well as Seaham Colliery, next visited, belongs to the Marquis of Londonderry, Lord-Lieutenant of Ireland.

A printed description of this colliery, and also of Seaham Colliery next visited, was furnished to the party at the colliery office; and is copied in the following pages with the kind consent of the managers.

A drive of six miles brought the excursionists to Seaham Colliery, where they were met by Mr Corbett, the agent for the owner, and Mr Barrett, the manager. A sumptuous lunch, kindly provided by the Marquis, was set out in the Volunteer Hall, adjoining the colliery. Mr Corbett took the chair, and soon all were enjoying the good things. In a few well chosen sentences, Mr Corbett welcomed the party and invited them to inspect the works, placing also the services of the mine officials at the disposal of those who wished to go underground. Mr Dixon, the President of the Institute, in responding, proposed the health of Lord Londonderry and Mr Corbett and the managers, and the toast was warmly pledged. After an examination of the plans of the colliery, a number prepared to descend, while others inspected the surface works under the guidance of Mr Corbett and Mr Barrett.

It was at this colliery that an explosion occurred in 1880, resulting in the loss of 164 lives. A monument erected in the churchyard near the colliery records the tragic event. The explosion is one of those treated by the Messrs Atkinson in their work on Explosions in Coal Mines. They traced the cause to a blown-out shot in a man-hole near the pit bottom. This shot-hole, with a few inches still left on, was pointed out to a number of the members. Previous to the explosion, the stables were of wood; these took fire, which was communicated to the coal, and thus became a source of great danger during the exploration of the mine, which had ultimately to be sealed up till the fire was extinguished. The stables are now all of brick-work, with walls dividing the stalls from each other, and arched over. No bedding is used, the stalls being paved with brick and kept clean.

The explosion has been the occasion of the introduction of several devices at the colliery tending to safety. Among these may be mentioned:—(1) A self-registering barometer on a large scale, being nothing less than a portion of the workings sealed up and having indicating apparatus connected, whereby alterations in the pressure of the atmosphere can be known earlier than is possible with an ordinary barometer. (2) A system of watering the underground roads, as well as the tubs of coal when they leave the working faces, so as to prevent explosions of coal dust.

(3) The establishment of a set of men trained in the use of the Fleuss breathing apparatus and lamp, which can be of service under water and in noxious gas, the apparatus being kept ready for immediate use.

This is an older colliery than Silksworth, and the fittings and machinery are of an older type. The winding engines on the two pits have single low pressure cylinders, 67 and 69 in. diameter respectively, and 7 feet stroke, with 21 feet drums. The underground haulage is extensive, the tail-rope system being that in use, with 60 tubs in each race.

Preparations were made for leaving at five o'clock, and three ringing cheers having been given for the officials, the party took to their machines and returned to Sunderland by way of Seaham Harbour, and reached Newcastle at seven.

On Saturday the Exhibition was visited. Special interest was taken in the section devoted to haulage, which is the most complete of the mining exhibits. The members had been specially invited by one of their number—Mr Eustace Smith, jun., of the firm of Thomas & William Smith, St. Lawrence Ropery, Newcastle—to lunch in the Exhibition at one o'clock. There was a full muster, and Mr Smith presided. The company having been regaled to their hearts' content, Mr Dixon proposed the health of Mr Smith, coupled with that of Mr Haggie and of Mr Sutherland, the other members of the Newcastle committee, to whose exertions the successful issue of the whole arrangements of the visit to Newcastle were in no small measure due—a visit which had given satisfaction to everyone. The toast was pledged with enthusiasm.

It was now almost time to make for home, but a number of the members took advantage of the invitation of the Council of the North of England Institute, and attended in the theatre of the Exhibition the annual meeting of that Institute, and heard part of the inaugural address of the president, Sir Lowthian Bell. At a later stage Mr Dixon had an opportunity of acknowledging, on behalf of the Mining Institute of Scotland, the very great kindness the members had received at all hands during their visit to Newcastle.

The train left Newcastle at 3.5 p.m., and arrived in Glasgow

in the evening. The weather had been delightful all the time; no accident had occurred: many had gained valuable information; all had derived no little pleasure.

DESCRIPTION OF SILKSWORTH AND SEAHAM COLLIERIES.

SILKSWORTH COLLIERY.

SECTION OF SHAFTS.

Sand, 7 feet, ...	at 54 fathoms.
Coal, 3 ft. 3 ins., ...	at 113 „
Five-quarter Seam, 4 ft. 2 ins., ...	at 186 „
Maudlin Seam, 5 ft. 6 in., ...	at 270 „
Hutton Seam, 4 ft., ...	at 290 „

DESCRIPTION OF COLLIERY.

There are two shafts. The upcast being 14 feet diameter, is lined throughout; the first 24 fathoms with plate clay bricks, the next 44 fathoms with metal tubbing lined with firebricks, and the remainder with plate clay bricks.

The downcast is 16 feet 7 inches diameter and has 50 fathoms of metal tubbing. This shaft is divided in the centre by a 3 inch wood brattice. The East side is fitted with iron guides and cages, drawing coals from the Maudlin Seam. The West side is similarly fitted and draws coals from the Hutton Seam.

The Pulleys are 16 feet diameter and run on frames 66 feet 9 inches high.

The Ropes are best plough steel, round ropes, 5¼ ins. circumference, weighing 28 lbs per fathom:

	T	C	Qrs.
Weight of rope over the pulley	4	10	0
Cage, 18 feet 6 inches high, 8 feet 6 inches long, 3 feet 3 inches wide, 4 decks, with 2 tubs in each ...	3	0	0
Tubs, 8, carrying 10 cwt. each	4	0	0
Weight of tubs, 5 cwt. each	2	0	0
Total lift ... Tons	13	10	0

The Heapstead is built entirely of iron and is double, one flat being 9 feet above the other. There are 36 screens, and 3 circular

screens, for re-screening the small coals, which are conveyed to them by travelling hemp belts and elevators.

Boilers.—Six cylindrical boilers, 44 feet by 5 feet, fired by Vicar's Patent Furnaces. 18 double tubed Lancashire boilers, 30 feet by 7 feet 6 inches, with 3 feet tubes, three of which are fired by Butcher's Patent Furnaces.

Winding Engines.—No. 1 (upcast) is a double horizontal high pressure engine; cylinders, 20 inches diameter, 3 feet stroke; geared 3 to 1; drum, 9 feet diameter; ropes, flat plough steel, 3 inches broad. This engine will eventually be removed for a hauling engine.

No 2 (downcast), drawing coal from the Maudlin Seam, 270 fathoms; a double horizontal high pressure engine with cylinders 48 inches diameter; 6 feet stroke; cylindrical drum, 25 feet 4 inches diameter, with two counterbalance chains weighing 8 tons each, working on rolls 3 feet diameter; steam pressure, 50 lbs.; and is fitted with automatic expansion gear; time of winding, 45 seconds; time of changing, 20 seconds.

No. 3 (downcast), drawing coal from the Hutton Seam, 290 fathoms; a double horizontal high pressure engine with cylinders 48 inches diameter, steam jacketed, 6 feet stroke; scroll drum from 15 feet to 28 feet diameter; fitted with automatic expansion gear; pressure of steam, 50 lbs.; time of winding, 48 seconds; time of changing, 20 seconds.

Crab Engine.—A double horizontal high pressure engine, with 10 inch cylinders, 2 feet stroke; drum, 6 feet diameter, with a jack engine underneath.

Pumping Engine.—For pumping water for the use of boilers and cottages is one of Hathorn and Davy's compound differential expansion engines; depth of staple, 213 feet; high pressure cylinder, 23 inches diameter; low pressure cylinder, 42 inches diameter; stroke, 5 feet.

Hutton Seam Hauling Engine is a double horizontal high pressure engine, with cylinders 30 inches diameter; stroke, 5 feet; four drums, 9 feet diameter, on shifting carriages; steam pressure, 50 lbs.

This engine also compresses air for a small hauling engine in the Maudlin Seam. Diameter of compressor, 30 inches; stroke, 5 feet. This engine is worked by three cylindrical boilers, 30 feet by 5 feet.

Maudlin North Hauling Engine is a double high pressure engine; cylinders, 18 inches diameter; length of stroke, 26 inches; three drums, two are 6 feet diameter, one is 7 feet diameter; geared at 3 to 1, and worked by two multi-tubular boilers, 12 feet 6 inches by 4 feet 3 inches; steam pressure, 80 lbs.

South Hauling Engine.—Worked by compressed air; two cylinders, 10 inches diameter; stroke, 12 inches; two drums, 3 feet 6 inches diameter; geared at 5 to 1; air pressure, 50 lbs.

Ventilation by furnace; 90 feet fire-grate, and underground boilers. Total quantity of air, 240,000 cubic feet per minute. Water gauge, 3 inches. 7½ tons of coal used per day in the furnace.

In the Maudlin North Engine Plane there are 3124 yards of 1 inch iron water pipes, with cocks every 40 yards for the purpose of watering the way to lay the dust.

No. of Horses and Ponies:

Horses	68
Ponies	241
	309

No. of Men and Boys employed:

No. of Hewers	510
„ Off-handed Men and Boys, underground ...	843
„ „ „ surface	443
„ Mechanics	96
	1892

No. of Houses	768.
Area of Royalty	2800 acres.

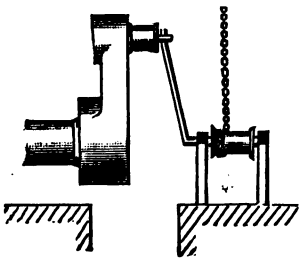
Lamps:

Tin Can Davys	586
Bonneted Mueselers	1100
	1686

Present Output.—2300 tons per day, which is capable of being

increased to upwards of 3000 tons per day, with the present winding engines, and it is intended to erect another winding engine at the upcast pit capable of drawing at least 1000 tons a day.

The indicator showing the position of the cage in the shaft is



worked from the crank of the drum shaft, as shewn in the annexed woodcut.

SEAHAM COLLIERY.

SECTION OF SHAFTS.

Limestone, ...	at 36	fathoms.
Main Coal, 6ft. 1in., ...	at 217	„
Maudlin Seam, 4ft. 5in., ...	at 226	„
Low Main Seam, 5ft. 2in., ...	at 237	„
Hutton Seam, 4ft. 8in., ...	at 254	„
Harvey Seam, 4ft. 2in., ...	at 281	„
Busty Seam, 2ft. 11in., ...	at 290	„

DESCRIPTION OF COLLIERY.

Nos. 1 and 2 Pits—Downcast, bratticed; diameter, 14 feet; ground broken, April 13th, 1849. No. 3 Pit—Upcast; diameter, 14 feet; ground broken, August 12th, 1845.

Seams Worked.—The beds of coal worked are the Main, Low Main, Maudlin, and Hutton Seams.

The No. 1 Pit side of the downcast shaft is the winding shaft

for part of the Hutton Seam and the whole of the Low Main Seam; the hanging on is at a depth of 1524 feet below the surface.

The No. 2 Pit side of the downcast is the winding shaft used solely for drawing the remainder of the Hutton Seam; the hanging on is at a depth of 1690 feet below the surface.

The No. 3 Pit, or upcast shaft, is the winding shaft for the whole of the Maudlin Seam and the whole of the Main Coal Seam; the hanging on is at a depth of 1520 feet below the surface.

The coals worked from the Main Coal Seam are dropped down a staple to the Hutton Seam Level, and brought out by an engine to the upcast. The coals from the Low Main Seam are brought through a drift to the Hutton Seam Level, and from thence to the No. 1 Shaft by the same engine which draws the coal from the Hutton Seam.

A little to the north of these shafts, a downthrow fault is met with of 105 feet, which accounts for one part of the Hutton Seam being drawn from a greater depth than the other.

Winding Engines.—Nos. 1 and 2 Pits—Two single acting condensing engines; 67in. diameter of cylinder; stroke 7ft.; pressure, 17lb.; vacuum, 12lbs.; two drums, 21ft. diameter; No. 1, erected 1849; and No. 2, 1850; boilers, four, 33ft. by 7ft. 6in., to No. 1 Pit, and four, 33ft. by 7ft. 6in., to No. 2 Pit.

No. 3 Pit—Single acting condensing engine; diameter of cylinder, 69in., stroke 7ft.; pressure, 20lbs.; vacuum, 13lbs.; two drums, 21ft. diameter; erected, 1869.

The whole of the above engines were made by Messrs Murray, of Chester-le-Street. Boilers, five, 33ft. by 6ft.

Hauling Engines Underground.—No. 1 Pit—Double acting; cylinder, 19in., stroke 3ft.; two 7ft. drums; geared 8 to 3; pressure, 43lbs.; three boilers, 33ft. by 6ft. Additional semi-portable in course of erection—Double acting; cylinder, 14in.; stroke, 20in.; two 5ft. 6in. drums; geared 3 to 1; pressure, 85lbs.

No. 2 Pit—Double acting; cylinders, 19in.; stroke, 3ft. 6in.; pressure, 50lbs.; three 6ft. drums; geared 3 to 2; two boilers, 40ft. by 5ft. Additional engine, placed 1¼ miles from the shaft

—Double acting; cylinders, 16in.; stroke, 3ft.; two 5 ft. drums; geared at 5 to 2; worked by air at 50lbs. pressure.

No. 3 Pit—Maudlin Engine. This engine is placed at bank, and the ropes are conducted down the upcast shaft in pipes. This engine was erected by the Grange Iron Company and commenced work, August 9th, 1886. Double acting, high pressure; gearing on the first motion; cylinders, 26in. diameter; pistons, Oldham's patent, stroke, 5 ft.; pressure, 100 lbs; fly wheel, 9 ft. diameter; two Lancashire boilers, 28ft. by 7ft., steel and double riveted.

No. 3 Pit—Main Coal Engine—Semi-portable, double acting; cylinders, 7in.; stroke, 12in.; two 4ft. drums; geared $3\frac{1}{2}$ to 1; pressure, 100 lbs.

Air-Compressing Engine in course of erection. Double acting; cylinders, 44in.; stroke, 6ft.; two air cylinders, 44in. diameter; stroke, 6ft.; speed, 12 strokes per minute, and pressure of air 55 lbs.; steam pressure, 50 lbs.; four boilers, 30ft. by 5ft., and three Lancashire boilers, 28ft. by 7ft.

Working Load for each Pit—

	T.	c.	q.
No. 1 Pit—Ropes, flat, $5\frac{1}{4}$in. by $\frac{7}{8}$in., 250 fms., weight,...	5	0	0
Tub, when empty, is 5 cwts. 1 qr.			
Tub, when full, 13 „ 3 „			
Cage, weight, ...	2	8	0
Six tubs, full, weight, ...	4	2	2
Chains, weight, ...	0	3	2
Working Load, ...	11	14	0

	T.	c.	q.
No. 2 Pit—Ropes, flat, $5\frac{1}{4}$in. by $\frac{7}{8}$in., 280 fms., weight ...	5	12	0
Tubs, as per above, weight, ...	4	2	2
Chains, „ „	0	3	2
Cage, weight, ...	2	8	0
Working Load, ...	12	6	0

	T.	c.	q.
No. 3 Pit—Ropes, flat, $5\frac{1}{4}$in. by $\frac{7}{8}$in., 250 fms., weight ...	5	0	0
Tubs, as per above, weight, ...	4	2	2
Chains, „ „	0	3	2
Cage, weight, ...	2	11	0
Working Load, ...	11	17	0

The Cage is treble decked and carries six tubs.

Pulleys—

Nos. 1 and 2 Pits, ...	16 feet diameter.
No. 3 Pit, ...	13 „ „

Hauling Ropes—

Total length on Colliery, ...	33.000 yards.

Output—

No. 1 Pit, ...	840 tons per day.
No. 2 Pit, ...	660 „ „
No. 3 Pit, ...	1500 „ „
Total, ...	3000

Men and Boys Employed—

No. of Hewers, ...	677
No. of Off-hand Men and Boys (underground), ...	1163
„ „ „ (surface), ...	346
No. of Mechanics, ...	133
Total Employed at Colliery, ...	2319

No. of Houses, ... 967

Horses and Ponies—

No. of Ponies (underground), ...	342
No. of Horses „	4
No. of Horses (above ground), ...	10
Total, ...	356

Safety Lamps—

The Number in use is—Can Lamps, ...	1900
Mueseler Lamps,...	207
Total in use, ...	2107

Pipes for Watering Main Ways—

Total length in use, ...	6300 yards.

Signalling—

The shaft signalling is done by electricity, as is also No. 3 Pit hauling engine. The latter is also connected with the underground workings by telephone.

Haulage—

The whole of the haulage is done by the Tail Rope System.

Sets—

The number of tubs on each train in the different pits is—

No. 1 Pit, ...	60 Tubs.
No. 2 Pit, ...	56 „
No. 3 Pit, ...	60 „

Tubs—

The size of the tub in use is—

Length, ...	3ft. 1¼in.
Breadth, ...	2ft. 5in.
Depth, ...	2ft. 4⅜in.
Standard weight, ...	8½ cwts.

Gauge of Way (underground), ... 2ft. 0½in.

Engine Planes—

The total length of Engine Plane in each Pit is—

No. 1 Pit, ...	5300 yards.
No. 2 Pit, ...	5200 „
No. 3 Pit, ...	5500 „

Guides.—The guides of the downcast shaft are wood, and those of the upcast are round wire ropes, kept in position by 34 weights each of 2 cwts., being suspended from each guide beneath the scaffold.

Speed of Winding—

	Running Secs.	Changing Secs.	Total Secs.
No. 1 Pit, ...	85 ...	25 ...	110
No 2 Pit, ...	90 ...	30 ...	120
No. 3 Pit, ...	95 ...	30 ...	125

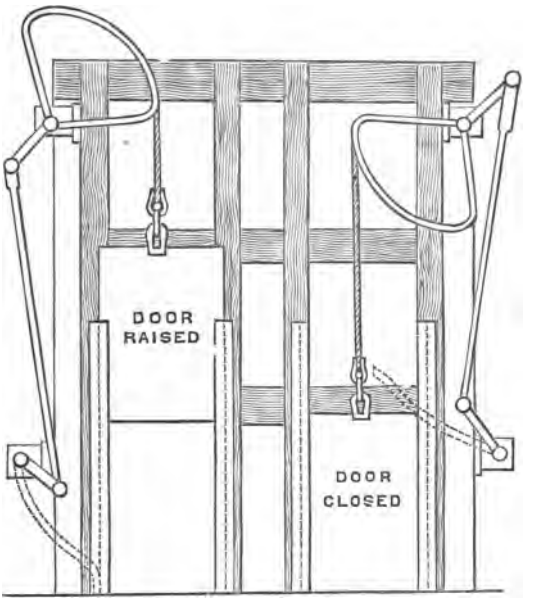
Ventilation.—This is effected by two large furnaces placed in the Hutton Seam. In addition to the furnaces, five boiler fires and one portable engine assist the ventilation. The average total quantity of air for the whole of the pits is 340,000 cubic feet per minute.

Consumption of Fuel at Furnaces—20 tons of coal per day.

Area of Royalty—9000 acres.

No. 3 Pit Self-Acting Doors.—The onsetting of No. 3 upcast shaft is done in the fresh air, a pair of self-acting doors being placed at the pit bottom. By referring to the drawing, it will be seen that a spanner projects into the shaft, and when the cage descends the side of the cage catches the spanner and forces it

down; at the same time, by an arrangement of levers, the quadrant is made to move in an upward direction, taking with it the door, which is thus kept up until the cage leaves the bottom, when

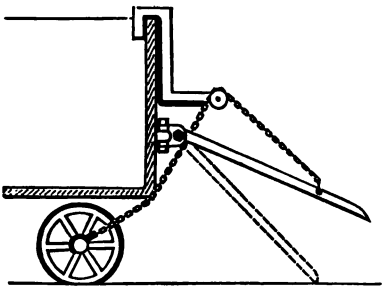


Self-Acting Doors at Pit Bottom.

the weight of the door brings it back again into position. It may here be remarked that the cage is boxed in to prevent the escape of air while the cage is in the bottom.

Cow for Preventing the Running Back of Sets.—A novel Cow for preventing the running amain of sets is in use, the invention of the resident engineer, Mr W. Rowell. A side elevation is shewn on sketch. A chair is suspended from the end of the last tub, and a chain attached to the Cow is brought over a pulley fastened to the chair. The extremity of this chain has a clasp which is placed on the axle of the tub and is kept on this axle by the forward movement of the tub, but the moment the set moves backwards the axle throws off the clasp and the Cow is brought into action. The

advantage of this Cow is that a very strong one can be used with no fear of rollers, sheaves, &c., being broken, as, while the set is in motion, the Cow is suspended in the air.



Dook "Jock."

Brickworks.—The kilns are Hoffman's Patent Annular Kiln, of which there are 12, each capable of containing 18,000 bricks; also two ordinary kilns capable of containing 10,000 each. It takes a month to complete the circuit in burning off the patent kiln. The produce is on an average 130,000 bricks per fortnight. Besides ordinary bricks, fireclay goods of various descriptions are manufactured. The chimney in connection with the above is 120 feet high.

Blasting.—This is done by electricity, gelatine dynamite water cartridges are used. Blasting is only done in stone drifts, the coal all being got by hand.

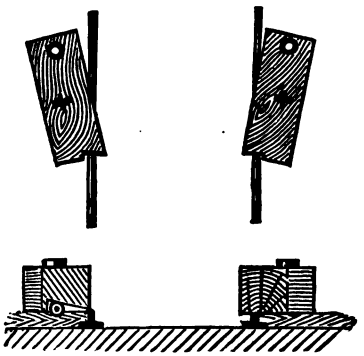
Fleuss Breathing Apparatus and Lamp.—These are kept ready for immediate use, and are worked by a staff of officials especially trained. The lamps and apparatus are pressed up to 260 lbs. with oxygen by means of a small hand pump.

Lamp Cabin.—All lamps are left here to be cleaned, examined, and tested. The cleaning is done by one of Ackroyd & Best's Lamp Cleaning Machines, which is driven by an "Otto" Silent Gas Engine.

Self-Registering Water Barometer.—A Self-Registering Water Barometer is in use. A small area of workings is hermetically sealed off, and a pipe from the interior acts in connection with a float placed outside the stopping, the variation of pressure being

recorded on a drum which is driven by clockwork. The changes of atmospheric pressure are shown much in advance of the ordinary barometer. A diagram of this may be seen in the Colliery Office.

Chock-Blocks for preventing Tubs running back on an Incline.—These blocks on being pushed aside by an upgoing hutch are at the same time raised on inclines, formed by slots cut in the



Chock-Blocks.

underside of the blocks, and moving on small wheels turning on horizontal axes. When the tub wheels clear them, the blocks run down to their position on the rails.

The following notes on some of the mining exhibits in the Newcastle Exhibition were then read :—

NOTES ON ELECTRIC APPLIANCES IN THE NEWCASTLE EXHIBITION.

By F. J. Rowan.

The electric appliances in the Exhibition present considerable variety and many features of interest.

Of applications actually made to mining work, however, there are few, and these are connected only with lighting and haulage; but it must not be overlooked that several of the other appliances illustrated may be useful in mining work, and that every application of electricity has at present a distinct educational value.

I.—ELECTRIC LIGHTING.

Systems of lighting by arc lamps and by incandescence lamps of small candle power individually have been so frequently illustrated that any description of these systems as found in the Exhibition is unnecessary. Specimens of both are in use, and they display the excellence and practical usefulness which are now looked for as a matter of course in these methods of lighting.

A feature of special interest in the lighting arrangements of this Exhibition is found in the employment of incandescence lamps of large individual candle power, much larger than any that have hitherto been shown. These lamps are in the main courts, and are of 100, 300, 500, 800, and 1000 candle power, and the use of these lamps has made it possible for the whole of the area inside the buildings to be lighted by incandescence lamps alone. So large an area has never previously been so lighted in this country. The total amount of light within the buildings is said to be equivalent to 150,000 candles, and with ordinary glow lamps this would require engines indicating about 1200 H.P. We are informed, however, that "the amount of power actually conveyed by the electric mains *in the Exhibition and grounds* is between 500 and 600 H.P.," but, on account of losses in steam engines, belts, and shafting, with about 5 or 6 per cent. in the dynamos, the indicated H.P. used amounts to about 1000 H.P. Even this, however, shows that the large glow lamps must be comparatively economical.

The 1000 c.p. lamp gives out, it is said, in light and heat, the equivalent of 2 H.P., requiring 3 to 4 indicated H.P. to keep it shining, with good machinery. "Using steam at a pressure of 80 lbs per square inch, one electrical H.P. can be obtained with noncondensing engines and first-class dynamos with from 60 to 70 lbs. weight of steam per hour, and with incandescence lamps this will give from 195 to nearly 500 nominal candle power, according to the character of the lamp. With arc lights a much greater nominal candle power can be obtained." During the Exhibition, tests are to be carried out with the different systems of lighting, in order to ascertain what amount of light can be obtained from them with one pound of steam per hour at the working pressure, and if these tests are carefully carried out, the information yielded by them will be very interesting and valuable.

The main roads in the model coal mine are lighted by means of glow lamps of ordinary size, the lamps being enclosed in air-tight cases to prevent access of fire-damp in case of accident.

Portable electric safety lamps for miners are also exhibited; one of Mr Swan's, having a secondary battery, having been hung up in the model mine, and several others, arranged with primary batteries, being exhibited in the North and West Courts. The writer and Mr Gilchrist had an opportunity afforded them, by the courtesy of Prof. Garnett, of examining the Swan lamps and seeing them in process of being re-charged, and Mr Sydney F. Walker, who exhibits one of the lamps having a primary battery, has promised the writer to send a specimen for exhibition to the members of the Institute.

The solution of the problem involved in providing an efficient and economical electric safety lamp for miners will probably be found in either of these systems of portable lamps, and, as the great importance of the subject to this Institute will lead to several of these lamps being subsequently described in detail to the members, it is unnecessary here to describe them further.

In connection with the production of the electric current used for lighting, there are some interesting features displayed in dynamos and engines. Foremost among these are the Turbo-Electric Generators of Messrs Clarke, Chapman, Parsons, & Co., of which there are 14 specimens side by side at one end of the

engine-room, and three others in the West Court. This engine is a steam turbine, or series of steam turbines, the steam for which enters at the centre of a long barrel or cylinder, and passes through the turbines to the ends, whence it returns to the exhaust pipe at the centre by means of a passage underneath the cylinder. The turbines are mounted on the same shaft which carries the armature of the dynamo, so that engine and dynamo stand on one bed-plate, and a machine capable of producing the same electrical output as a dynamo and engine of 50 indicated H.P. occupies a floor space of only 10ft. by 1ft. 6ins. The small size of these generators in relation to their output is due to the high speed at which they are run. Being carefully balanced, this speed is as high as 9000 revolutions per minute, which is attained with the minimum of vibration, the only inconvenience being the humming noise produced. The steam valve is controlled by a very ingenious magnetic and exhaust governor. A magnetic arm or bar turning on a pivot on the top of the dynamo has its position controlled by the magnetism of the field magnets, and it opens or closes a small aperture by which air is admitted to small circular bellows exhausted by a turbine on the engine shaft. The lever acting on the steam valve is connected to the moving side of the bellows, and opens or shuts the valve as the bellows open or collapse. Lubrication is carried out automatically by circulation of the oil caused by difference of temperature; the oil being heated in the engine and cooled by copper gills or radiators placed on one side of the bed-plate. Special flexible bearings used in the generator, and a very long commutator, with several brushes capable of being moved along it horizontally, prevent undue wear consequent upon the very high speed.

In the engine-room are also two dynamos, having each four poles (instead of the customary two poles), made by Messrs Paris & Scott. The use of the four poles shortens the length of the magnetic circuit and economises the power required to maintain the magnetic field. These dynamos have also very long bearings and a special form of armature, and in result show a large output in comparison to their weight.

In the circuits from these dynamos, Messrs Paris & Scott have introduced an ingenious magnetic cut-out by which any circuit is

automatically broken, if through any cause the current exceeds its proper strength by 25 per cent. Each cut-out consists of a small bar of iron wound with wire, which becomes magnetised in proportion to the current passing through the wire. If magnetised beyond a given degree, it acts on an iron lever, which, on being lifted, releases a detent, allowing a weight to fall over and break the circuit by lifting copper connections out of a mercury cup.

The use of transformers, or as they have been called secondary generators, is also illustrated to a small extent by specimens of two different systems. One of these is a compound machine, consisting of a motor and dynamo in one, wires of different resistance being used to drive the machine by high tension current, while low tension current for lamps is produced in the larger wires. The other transformers are Gaulard & Gibb's induction coils, which are used in connection with alternating currents of high tension.

II.—HAULAGE AND TRACTION.

The most interesting exhibit from a mining point of view in this department is that of a 5-H.P. Immisch electro-motor applied to an example of endless rope haulage plant amongst the haulage exhibits. This motor runs at about 1200 revolutions per minute, is geared to the 60-inch driving sheave by worm wheel and screw gearing, which runs in oil, and is reversed by means of a double set of brushes, one of which is thrown on to the commutator of the motor by the reversing lever. The points of support for the brushes are arranged to compensate for wear in the commutator surface, so that the angular positions of the points of contact of the brushes remain unchanged.

The members had not an opportunity of seeing this motor in operation owing to some hitch in the arrangements with the exhibitors of the steam engine, which was also coupled to the same drum, and Mr Immisch complains that the screw gearing applied was not properly efficient, so that his motor had not fairplay when running. It showed, however, that there is no difficulty in applying electro-motors to this class of work when the requisite proportions are satisfactorily observed.

The electric railway working in the garden, although used to run a tramway car, illustrates another form of haulage (viz., by traction), which has been carried out in mines in Saxony and Prussia, and more recently in the Wisconsin mines. This railway has a gauge of 4ft. 8in., and has an insulated conductor or rail in the centre of the permanent way, through which the motor receives the current from the dynamo in the engine room. The motor weighs about 30 cwts., and is capable of developing about 20 H.P. at 800 revolutions per minute. It is geared to the shaft of the bogie or locomotive, running at 200 revolutions, by spur and pinion gearing, having V-shaped teeth, or "double helical gearing" as it is called. Resistances are arranged so that at starting and when the motor speed is low they are thrown into the circuit to prevent an undue current being passed through the motor coils. As the speed increases these resistances are thrown out, and the resistance of the circuit is thus made as small as possible. The speed of the locomotive and car is about 12 miles an hour.

Another system of traction, viz., that in which the locomotive or vehicle carries its own source of power in storage cells, was to have been exhibited by means of an electric cab, but it had not arrived at the Exhibition at the date of our visit. This cab is to weigh 12 cwts., and is to carry a sufficient number of storage cells to develop 1 H.P. for four hours, or for an ordinary journey of forty miles without change of the accumulators.

Another example of the same application to traction is being carried out at present by Mr Radcliffe Ward, who has been working at this question for a considerable time, and was probably the first to turn his attention to it.

Specimens of wire-rope railways worked by an endless rope, and of a Telpher line worked by electricity, are shewn, but these are suitable only for small weights carried above ground, and therefore have not much interest where railway communication exists.

III.—MOTORS.

Several specimens of small electro-motors in operation are to be seen—these motors being all of Immisch's design. They are applied to working models of marine engines, driving a pipe-

maker's lathe, and working a ventilating fan used for ventilating an office near the entrance to the Exhibition. These motors are worked from storage batteries or from the main lighting circuits, and some of them have very neat automatic speed governors, the invention of Mr Gisbert Kapp. "The governor consists of two springs, which, when the armature rotates, become strained by centrifugal force and causing a brass contact piece to slide along the shaft and throw resistance coils out of circuit, as the back electromotive-force of the motor increases with the speed. If the speed be reduced, the springs return, and the resistances are again brought into the circuit," so that when the motor is at rest, or on starting, the whole of the resistance is in the circuit, and excessive current in the armature is prevented.

IV.—GOVERNORS.

In addition to the electric governor for motors, just mentioned, an electric governor for steam engines is shewn on a Robey engine, which is also fitted with Proell's automatic expansion-valve gearing.

V.—MACHINE TOOLS.

The writer's electro-magnetic drilling and rivetting machines are also installed in a building outside the engine-room, but need not be further mentioned here except as, with the foregoing appliances, illustrating the varied practical uses to which electricity is being applied, and its great convenience in carrying out difficult operations, and in the distribution of power.

NOTES ON THE HAULAGE EXHIBITS AT THE NEWCASTLE EXHIBITION.

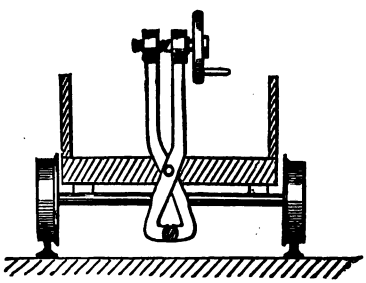
By John Gemmell and James Hamilton.

At this Exhibition several systems of underground haulage are shewn in actual operation, and it has been thought that a short description of these would be of value, particularly to those members of the Institute who have not had an opportunity of inspecting them.

No system is exhibited which does not permit of the tubs passing round a somewhat sharp curve, and the different modes are shewn passing round a turn of about 90° and 20 yards radius.

I.—DOUBLE ROADWAY SYSTEMS, ROPE UNDER TUBS.

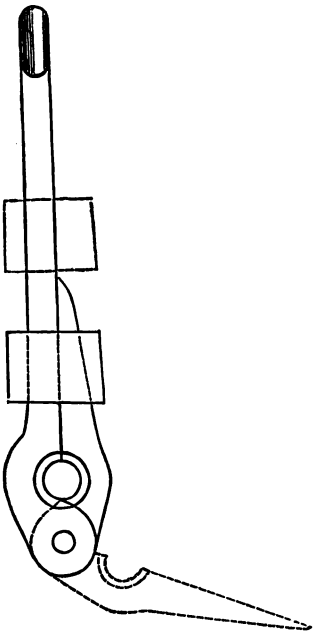
1. A double roadway system with the rope under the tubs, and the tubs run in sets of fourteen, is shewn by the *South Durham Coal Co.*, Bishop Auckland. The connection to the rope is effected by a bogie carrying a clip or gripper actuated by a screw, as indicated on the woodcut. The clip is pivoted on the



South Durham Coal Company's Bogie.

bogie frame, and readily passes round the turn on small sheaves fixed to the sleepers by iron hasps passing over them. This system is employed on a plane 4000 yards in length.

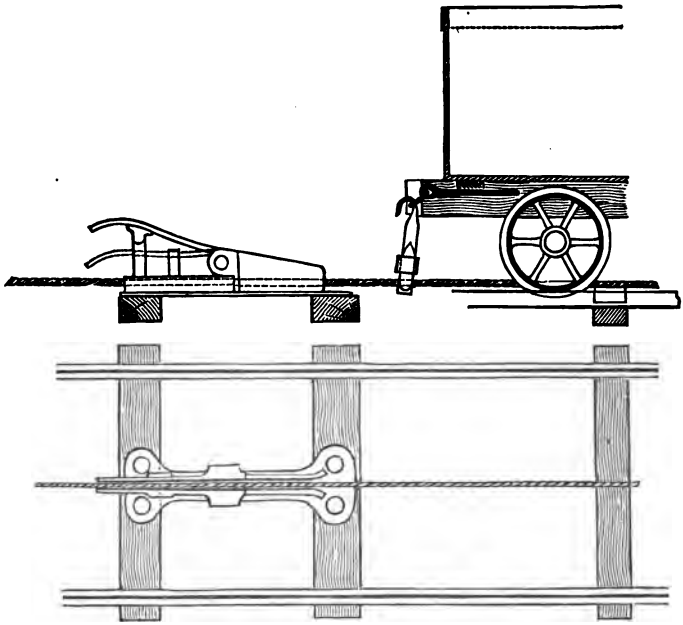
2. *The Castle Eden Coal Co., Ltd.*, West Hartlepool, also exhibit a double roadway endless rope system, with the rope carried underneath the tubs on small rollers; but in this case the hutches travel on the rope singly, and at intervals. They are attached by means of Fisher's patent clip, which is hung on the drawbar, and grips by being carried out of the perpendicular, and so



Fisher's Patent Clip.

deflecting the rope. As the cut shews, it is jointed at the bottom, folds over the rope, and is kept in position by a sliding thimble. It did not seem to be very easily attached to the moving rope. There was, however, shewn in operation a very sweet-working automatic detacher for these clips. The rope and the lower part of the clip passes under and between the jaws of the detacher, which as the tub moves on pushes up the thimble, so that the clip as it passes out falls open. The extension of the jaws is made by two levers pressed up by a weight so as to accommodate

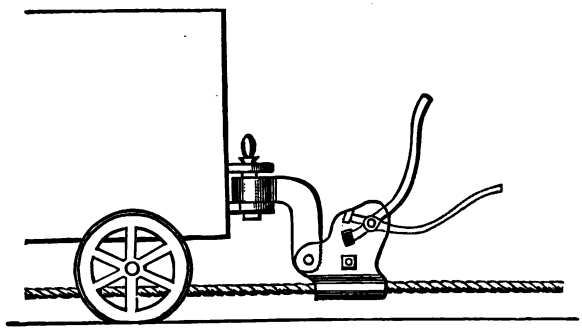
themselves to different positions of the thimble. The rope is led



Automatic Detacher for Fisher's Hook.

round the curve on small bottom sheaves set close together.

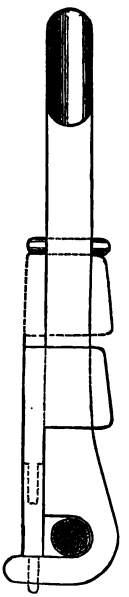
3. A similar system—double roadway and rope underneath tubs, with tubs attached singly—is exhibited by *The Whitburn Coal Co.*, Marsden Colliery, South Shields. The clip used is Morgan's patent, the appearance of which is shewn by the sketch.



Morgan's Patent Clip.

It does not hold by deflecting the rope, but by a gripping action. It is composed of two cheeks or jaws, which are kept together by a bolt and nut, and are connected by a loose rivet to the iron carrier attached by a pin to the hutch. In the inside of the upper part of these jaws slots are cut, deep next the bolt and narrow towards the top. In these slots the thickened end of a lever moves. When the longer arm of this lever is forced into the dotted position, the thickened head moves upwards into the narrow part of the slots, forcing the upper part of the jaws outwards, and consequently—since the bolt and nut hold the jaws at the middle—pressing the lower part of the jaws inwards on the rope, and so gripping it. The nut is screwed up by hand, so as to get the necessary bite when the lever is depressed. In this case also the rope is carried round the turn on small bevel pulleys.

At Marsden Colliery these clips are used on gradients as steep as 1 in 6 with the load. The tubs are attached at distances of thirty to forty yards apart, and the speed of the ropes is about three miles per hour.



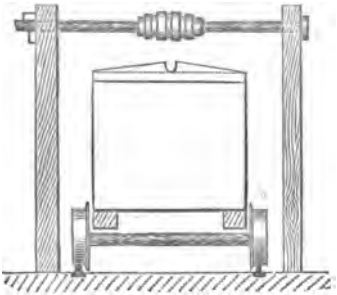
Rice's Patent Clip.

4. *The Hodbarrow Mining Co.*, Millom, Cumberland, are also exhibitors of a system of endless rope haulage, with the rope on the ground, the hutches being attached at intervals by means of Rice's and Fisher's patent clips. Rice's patent hauling hook is of very simple construction, as the sketch shews, and, like Fisher's, also acts by deflecting the rope. The thimble carries a guard which is pointed, and falls into a hole in the bottom of the hook. It is very easily attached and detached, and the boys at the Exhibition, who work with all the different hooks, preferred this one, although it had no automatic detacher.

II.—DOUBLE ROADWAY SYSTEMS, CHAIN OR ROPE OVER TUB.

1. The endless chain system is erected and exhibited by the

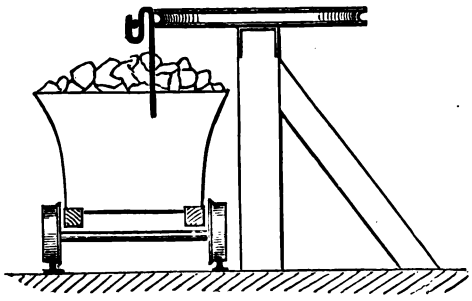
Tyne Coal Company Limited, as employed by them at the Hebburn and Wallsend Collieries. The tubs are lip-filled and the chain is gripped by a notch in an iron plate on the top of the hutch end.



Roller and Tub for Endless Chain.

There is no special appliance used and the curve is managed in the usual way, by raising the chain out of the notch before entering on the turn and allowing both full and empty tubs to run round the curve by gravity on inclines. Boys are needed to reconnect them to the chain.

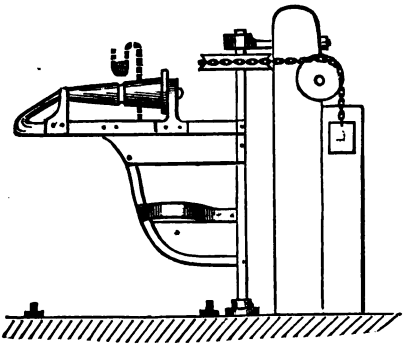
2. *The Bedlington Coal Company*, Bedlington Colliery, have erected an endless rope system with double way and with the rope carried on the top of the hutches, which are attached singly by means of jiggers fixed to the centre of the tub ends and high enough to permit of the hutches being filled some distance above



Jigger Attachment on Bedlington Tubs.

the lip. The rope is led round the curve on a series of sixteen large pulleys placed in a horizontal position, as shewn on the

sketch, against which the jiggers bear. In order to keep the rope from falling off these pulleys, there is placed at each end of the curve a self-acting swing gate, carrying a conical roller, and



Self-Acting Swing Gate, Bedlington Haulage.

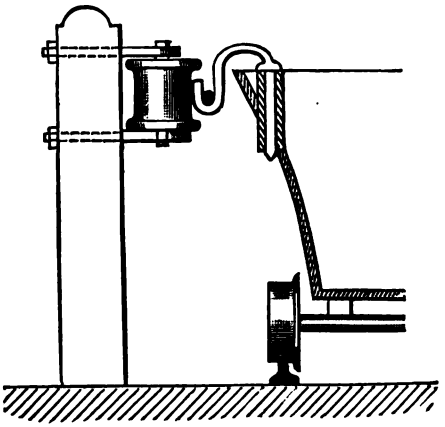
kept in position across the roadway by two weights, one of which is shewn on the sketch. When the hutch approaches the curve it strikes the bow on the lower part of the gate, forcing it open and raising the weight, which, when the hutch has passed, brings it back to its position across the roadway, the roller always going under the rope. For the purposes of the exhibition the hutches were all run round the curve and then brought back again, so that there was a long length of rope left unsupported by tubs, and this was met by carrying the rope on these gates placed at intervals on the straight road. They did not seem to act sweetly, the hutches striking them very hard.

3 *The Seaton Delaval Coal Company* shew an endless rope system on a double way as used at the Seaton Delaval Collieries, each tub being attached singly to the rope by *two* side jiggers inserted into sockets on the sides of the iron hutches. This arrangement admits of the hutches being top filled.

In actual working the tubs are 10 to 20 yards apart, and the speed of the rope is about two miles per hour. The roads are perfectly straight, and when branches are worked the hutches leave the rope, run round the curve on inclines, and are then attached to the branch rope.

As shewn at the exhibition, however, the hutches are passed

round the curve, without being detached from the rope, by a series of pulleys so placed as to carry the rope close to the jiggers as



Jigger Attachment, Seaton Delaval Tubs.

the wood-cut shows; but unless the tubs were placed close together the rope would have a tendency to fall off these wheels altogether.

III.—THREE-RAIL SYSTEM.

The Harton Coal Co. Ltd., South Shields, exhibit an endless rope working on a road with three rails, a fourth rail being added at the pass-bys; but there are, of course, neither points nor crossings. The tubs are attached to the rope, in actual

Harton Clip.

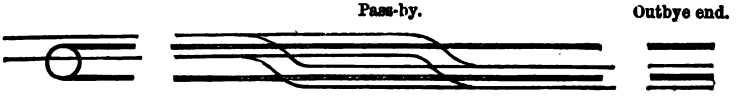
working, in sets of about fourteen, by means of the clip shewn on the sketch. The jaws of this clip are forced together by a set-

screw, and its shape is favourable for passing the bevel wheels on the curve. It is necessary in this system that the trains should be attached at exactly equal intervals, in order to avoid collisions at the pass-bys, and for the same reason there must be no slipping of the gripper on the rope. The latter risk is guarded against by winding the rope with tarred string at the place where it is caught by the clip, and this should also serve to prevent injury to it. The engine must be stopped every time the sets come to the pass-bys, in order to allow of the disengaging of an empty set, and the hanging on of a full race at the in-bye end and *vice versa* at the shaft. It was on this three rail system with pass-bys that the promoters of the Glasgow Subway proposed to work their undertaking.

IV.—SINGLE LINE SYSTEMS WITH PASS-BYS.

The Harton system and the two next following, viz., the Moresby and the Tredegar systems, have this in common, that they are evidently designed to meet the difficulty of making and maintaining roads, wide enough for a double way, in seams having bad roofs.

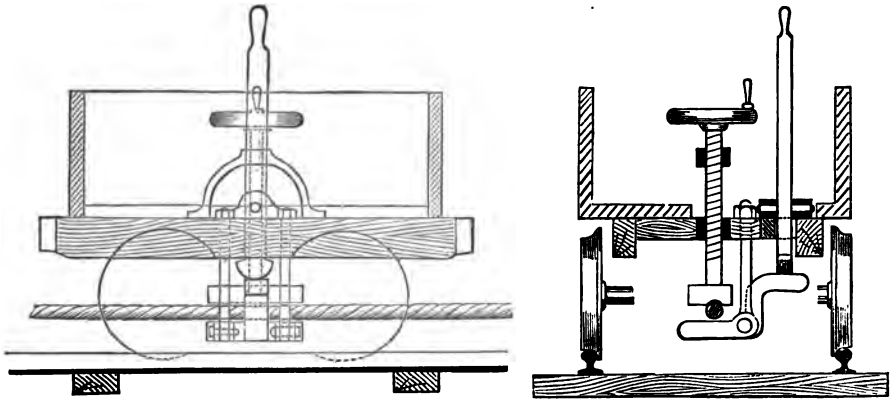
1.—*The Moresby Coal Co. Ltd.*, Whitehaven, exhibit a somewhat peculiar system of endless rope haulage, designed by Mr Ramsay, and in use at their Walkmill Pit. It is worked on a single roadway, with one pass-by or siding about mid-distance, where the full and empty tubs pass. Only one rope lies between the rails, the other one being carried on rollers outside the way.



Pass-by in Moresby Coal Company's Haulage.

At the same time as the empty set is being drawn from the shaft to the middle siding by the ingoing rope of the endless band, the full race is being drawn from the in-bye end towards the siding by the outgoing rope, and when both trains have arrived at the pass-by they are disconnected and attached to the opposite ropes; the engine is then reversed, so that the empties

are drawn from the pass-by to the inside by the rope which pulled out the full train, and the full train is drawn into the shaft by the rope which drew the empty race to the mid-siding.



Bogie with Ramsay's Patent Knock-off.

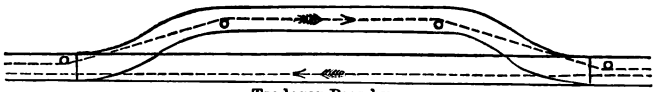
The rope is in the centre of the way and underneath the hutches, which are run in races, and are attached to the rope by means of clutch bogies. The catch is shewn on the sketch, and is of an ordinary kind, but it is fitted with an ingenious "knock off" arrangement, which is patented by Mr Ramsay. The lower jaw, against which the rope is jammed by means of a screw, is not made fast to the bottom of the bogie, but turns upon an axis parallel to the rope, and is held in position by the shorter arm of a vertical lever. When the upper and longer arm is knocked out of the perpendicular, the lower jaw of the clamp falls down and releases the rope. The lever being brought to the vertical, the jaw is of course raised again.

Instead of a horizontal bar or beam being laid across the roadway to "strike off" the bogie at the sidings and ends of the plane, a vertical jointed bar three or four inches broad is hung from the roof, the joint permitting the bogie to pass with the rope in one direction, but knocking it off if going the opposite way.

In actual working two clutch bogies are employed, one attached to the front, and the other to the rear of each set, by about six feet of chain.

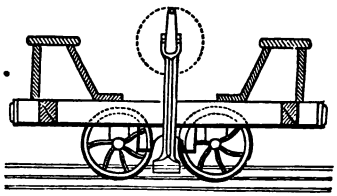
The rope is kept in position on the curve by twelve steel sheaves, nine inches diameter by six inches in height.

2. In the *Tredegar Coal Co.'s* system of endless rope which is employed at the Tredegar Collieries, Monmouthshire, sidings are placed at intervals, and the two ropes, six inches apart, and equidistant from the centre, both lie within the rails, being carried on ground rollers. At the pass-bys the one rope continues



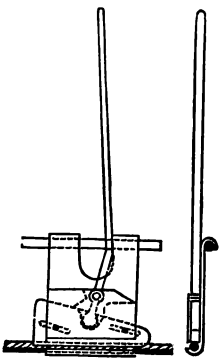
Tredegar Pass-by.

straight on, and the other is conducted round the sidings on small pulleys. Where the rope crosses the rail at the sidings, a shifting rail is used. The tubs are run in sets of from 15 to 35, according to the gradient, and the attachment to the rope is by means of a bogie carrying a gripper, which is suspended from

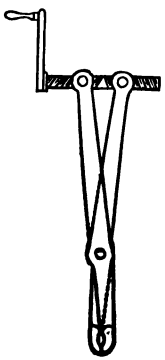


Tredegar Bogie.

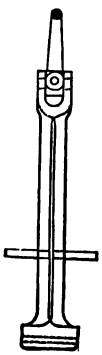
sockets in an iron frame in the bogie. The gripper has two



Hanson's Clip.



Screw Clip.



positions, over the ingoing and outcoming ropes. The gripper

first used at Tredegar was Hanson's clip, but it was found that the bogiemen did not throw off the rope when the train was stopped, and the result was unnecessary wear of rope and clip. To prevent this the screw clip sketched was substituted. This clip frees the rope immediately the train is stopped. The tramway is laid with steel sleepers, with the Colquhoun patent fastening made by the Tredegar Coy. In this fastening two holes are

Tredegar Steel Sleeper.

punched in the sleeper, one on each side of the bottom flange of the rail. Through these holes a steel clasp is passed, the inner end of which grips the bottom flange of the rail, and the whole is firmly bound together by a wooden key driven between the rail and the outer end of the clasp. The gauge is 2′ 4″, and the weight of the sleeper 14 lbs.

In actual working, the speed of the rope is about 3½ miles per hour, and the system admits of the working of curves as sharp as 20 feet radius.

This system was occasionally driven by an electro-motor, which was intended to be used underground by the Walker Coal Co.

V.—TAIL-ROPE.

The ordinary tail and main rope system, which has been so much employed in the Northumberland and Durham coalfields, drawing races in some cases of 80 to 100 tubs, is shewn in action by the *Hetton Coal Co.*; but there is nothing noteworthy about the arrangements.

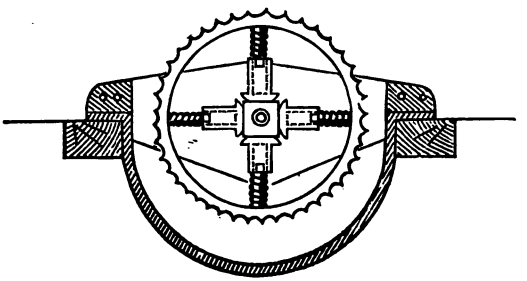
VI.—LOCOMOTIVE ENGINES.

There is no example of underground steam locomotives; but

the *Earl of Durham* exhibits Lishman & Young's Patent Air Locomotive, in use at Lambton Colliery, and which is described in the Transactions of the Institute, Vol. I., page 177. For level roads this system of haulage seems to leave little to be desired.

The engine has four wheels running on a gauge of 2′ 9½″, and two cylinders 4″ dia. and 7″ stroke, working under a pressure of 400lbs. per square inch. The air is compressed by a vertical engine having two steam cylinders 12″ dia., and two air cylinders 8″ dia. The compression is effected in two stages, and the air finally stored in a receiver from which the locomotive from time to time draws its supply.

There is also shewn at work DUNFORD & EMEN'S PATENT AUTOMATIC HUTCH GREASER. The greasing wheel has a corru-

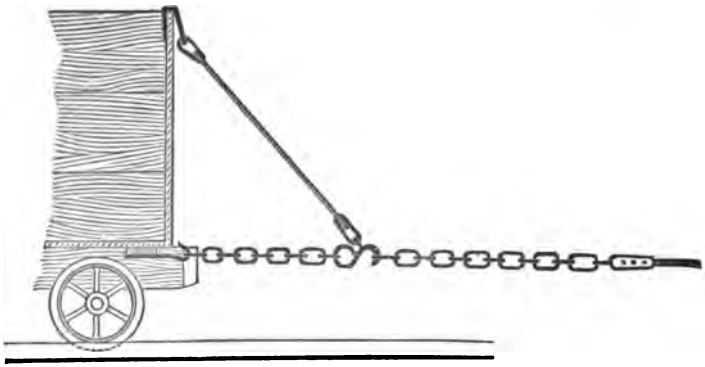


Dunford & Emen's Hutch Greaser.

gated iron rim, and its four short arms have an elastic connection with the boss through spiral springs surrounding them, and enclosed in tubular cases interposed between the rim and boss. On the flat faces of the boss the feet of the cases slide freely. As the hutch passes over, the grease is raised in the corrugations and the springs allow the wheel to be depressed so as to adapt itself to different heights of axle.

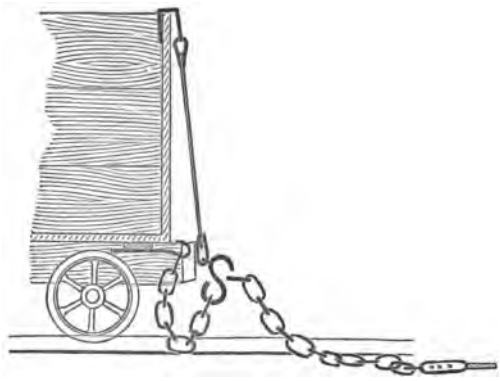
There is also exhibited an example of HETTON COLLIERY KNOCK-OFF NO. 1, for detaching a hauling rope from a race when the engine is stopped. It consists of a flat rubber band, con-

nected at one end by a hook to the top of the tub, and at the



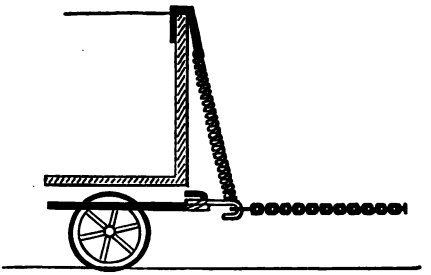
Hetton Knock-off No. 1.

other to the hook to which the drawing rope is attached. When



the hauling rope slacks, the rubber draws up the latter hook and so detaches the race.

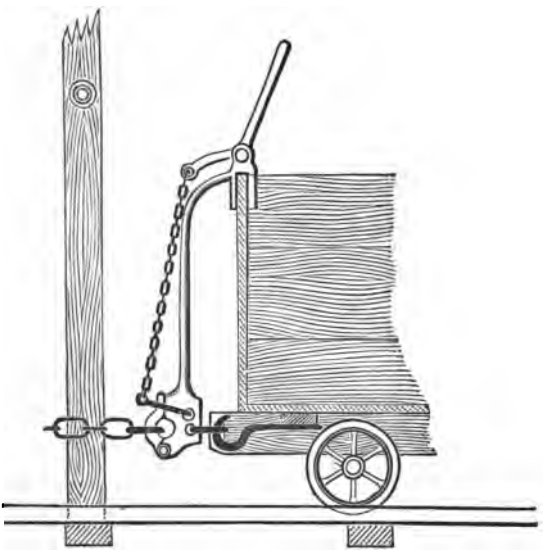
An example of a similar KNOCK-OFF was seen at Seaham



Seaham Knock-off.

Colliery, but instead of a rubber band a steel spiral spring was used.

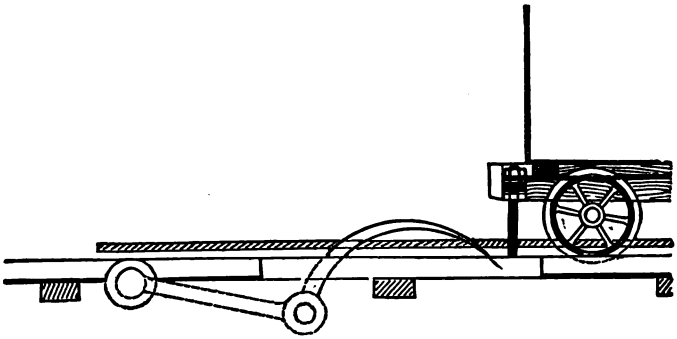
HETTON KNOCK-OFF No. 2, actuated by a lever releasing the



Hetton Knock-off No. 2.

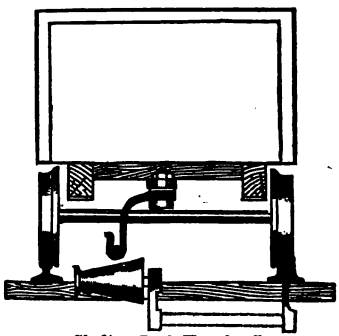
hook, on coming in contact with a horizontal striking bar, is very simple, and the sketch explains itself.

SKELTON PARK KNOCK-OFF is more complicated, and is designed to disconnect the rope from jiggers fastened to the underframe or drawbar of the hutches. It consists of a horizontal axle carrying two arms of equal length. One of the arms has a



Skelton Park Knock-off.

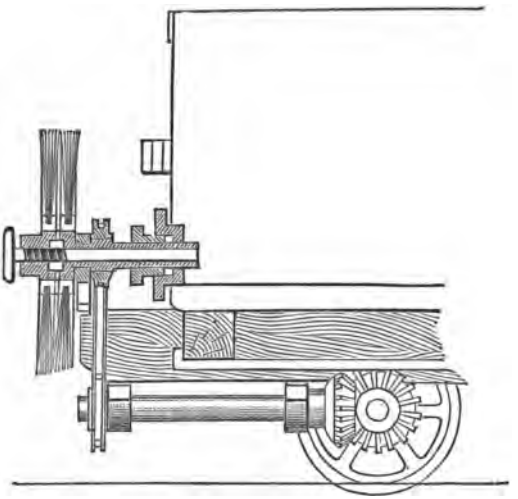
circular disc, which passes up through the centre of a split rail and projects about 5½ inches above it. The hutch wheel on passing over thus depresses this arm 5½ inches, at the same time raising the other arm a like distance. This other arm



Skelton Park Knock-off.

carries a steep cone roller. This roller raises the rope out of the jigger and it then slips or "fleets" down the steep cone clear of the jigger altogether.

Mr T. O. Robson, Redheugh Colliery, Gateshead, has on view a water tub fitted with ARCHER AND ROBSON'S PATENT SPRAYER for laying dust in mines. A hollow spindle passes through a

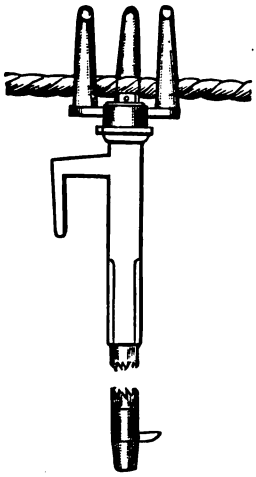


Archer & Robson's Sprayer.

stuffing box in the end of the tub. On its outer end is a hollow boss with holes perforated around it. Over this inner boss is fitted a chamfered wooden boss, also perforated, and surrounded by a circular bristle brush. The spindle, boss, and brush are rotated by an endless chain driven by bevel gearing on the tub axle. The water flows along the hollow spindle, through the perforations in the boss, to the brush, from the bristles of which it is driven in the form of fine spray by centrifugal force. There is an arrangement for shutting off the water either by a screw, or as in the case of the hutch exhibited, by a stop valve moved by a rod passing through the body of the tub.

The owners of *South Derwent Colliery*, Durham, exhibit a very smooth-working model of endless rope haulage. The hutches are connected singly to the rope passing over them by RUTHERFORD & THOMSON'S PATENT HAULAGE CLIP-FORK, shewn in

sketch. This clip-fork is an application of the principle of the toggle joint, and its grip of the rope is equally firm in whichever

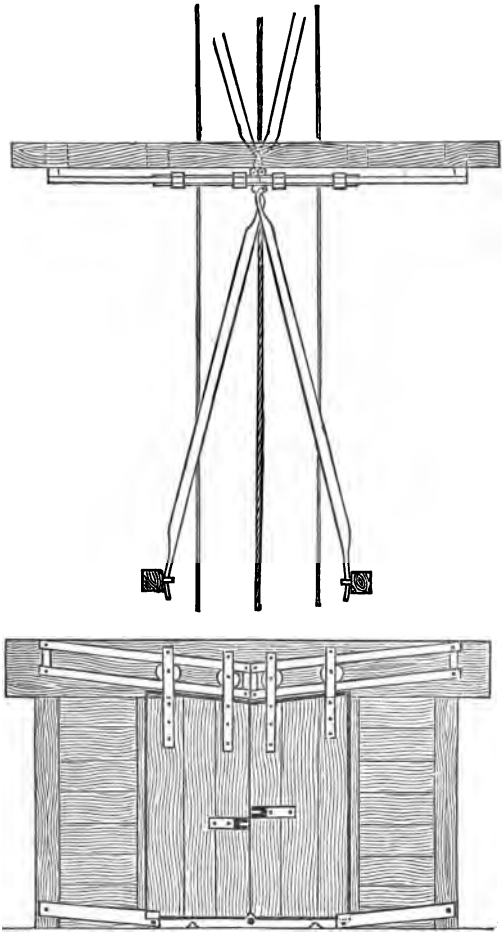


Rutherford & Thomson's Haulage Clip Fork.

direction the load may act. The rope is carried round curves on a pulley of large size, the hutches being detached automatically, run round the curve by their own gravity, and the rope is gripped anew by the clip. The tubs in the Model Coal Mine in the Exhibition are fitted with this clip-fork, but they are not shewn at work on a full size scale anywhere in the exhibition.

Not the least interesting of the exhibits in the haulage division (Whitburn Coal Company's section), is a SELF-ACTING VENTILATING DOOR for haulage roads, a plan and elevation of which are appended. It will be seen that the door is in two divisions, or leaves, both of which are hung by pulleys on rails, inclined so that the two leaves run close together of their own weight. Hinged to the edge of each leaf where it touches the other, and about two feet from the bottom of the door is a bar about eight feet long of angle or other stiff section of iron, and the other end of the bar passes loosely through an eye fixed in a prop, and about the same distance from the pavement, the prop being set so near the rail as simply to allow the tubs to pass. A tub on approaching the door encounters these bars and presses

them outward, gradually opening the two leaves of the door, which gradually close again as the tub passes out from between



Self-Acting Ventilating Door.

the corresponding bars on the other side. The door is opened and shut in a similar manner when a tub passes through it in the opposite direction. In the ordinary trap door the tubs often strike very hard; but in this case the doors are opened without shock.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD IN THE

ROOMS OF THE CHRISTIAN INSTITUTE, GLASGOW,

29th September, 1887.

JOHN M. RONALDSON, Esq., in the Chair.

About 30 members were present.

The minutes of the former meeting were read by the Secretary and confirmed.

The following were elected by ballot as ordinary members:—

GILBERT M'PHERSON, Jun., Stair, Ayrshire.
JAMES M'GILL, Clippens Oil Coy., Loanhead.
ROBERT PENMAN, Caledonian Boiler Works, Dalmarnock Road, Glasgow.
ROBERT FORRESTER, Gavell House, Kilsyth.
JOHN A. M'CALLUM, Jun., Rochsoles Colliery, Airdrie.

The following discussions then took place:—

DISCUSSION OF MR CHRIGHTON'S PAPER ON "THE SCHIELE COLLIERY VENTILATOR."

The SECRETARY read the following communication from Mr JAMES F. WALDIE:—I may mention, in connection with the Schiele fan discussion, that the Legbrannock District Collieries Coy. have had a 5 ft. fan of this description for nearly two years at No. 5 Pit, driven by a 9 in. horizontal engine with a 5 in. belt, the fan running 500 revolutions per minute, and giving 11,000 ft. of air at this speed. The air-ways are 17 ft. area, but I don't know the water-gauge. Whilst this fan serves its purpose well enough, we find the Guibal fans—of which we have two (18 ft. and 16 ft. diameter), both on forcing principle—much more reliable and less costly, both in running and upkeep, than the Schiele.

The CHAIRMAN, as no one was prepared to discuss the paper further, closed the discussion.

DISCUSSION OF MR HOGG'S PAPER "ON EXPLORING THE WORKINGS OF A COLLIERY AFTER A SERIOUS EXPLOSION."

Mr DAVID DUNN said Mr Hogg described pretty fully what was necessary to be done at the top of a pit after an explosion, and gave a few useful hints from which any one who might be in such a situation would benefit. As to the necessity of a competent person being in charge at the top, when the explosion occurred at Nitshill, the late Mr MacCreath was appointed to take charge on the top. He was a mining engineer, and a man of great experience; and he heard the late Mr Hood and others remark on the efficient way in which he had discharged the duties devolving on him. What had been suggested by several members he noticed had special reference to Udston Colliery. There were many competent managers present on that occasion, and he did not know why one of them was not appointed to take charge. Indeed, there must have been some misunderstanding on the point, for he was sure any of them would have gladly taken

up the position. He was informed in the colliery office that Mr Moore was in charge of the arrangements, but that gentleman had contradicted that at the Inquiry, and there was confusion over the matter.

The CHAIRMAN said the point was to get everything into working order as quickly as possible, and let every man who has anything to do with it have his defined duty. Of course, the responsibility must come from those connected with the colliery. He should say that was the way to get things set agoing, and different arrangements could be made afterwards.

Mr HOGG said he quite agreed with Mr Gilchrist's observations that some one should be appointed on the top to take entire charge. It would tend very much, doubtless, to the speed of the work. He had purposely refrained from referring to Udston in his paper. Of course, his experience was limited to that place. Still, what he stated was intended to be of use in similar circumstances. While it was impossible he could go into the subject as if he had been through half-a-dozen experiences, still it was intended that it should not apply to Udston only. The paper was intended to reassure managers who might suddenly be placed in a position of that kind, so that they might take at the work with some freedom though it might be new to them. What he wished to do particularly was to let them see that what was wanted was a little spirit, a little hard work, and to put fear from them as much as possible. There was one interesting thing he might mention which he learned when at Seaham Colliery lately. The manager there said that with the aid of the Fleuss apparatus one of the seams was opened up after an explosion some months sooner than could otherwise have been done. They were afraid the workings were on fire, and they feared to drive the ventilation inwards until they inspected the workings. The method they adopted was to inspect the working for a certain distance by the aid of the Fleuss apparatus, and so ultimately worked their way in the whole distance.

Mr RALPH MOORE said he did not know that there was much more to be said as to the way to conduct those explorations. His impression always had been that the great thing was to place the

power in one man,—the power to lay down a system; and he of course could be guided by the managers who were present as to the best mode. That decided, the next thing was to place the managers in as many districts as the plans might tell them was necessary. The manager of the district should have the power to select the men that he wished with him. What they did at Udston was: a plan of operations was decided upon, and colliery managers present were selected as the heads of each department. These managers were furnished with rough tracings of the plan. Each manager was to stand eight hours, and others were to take their places and were to follow on for other eight hours. The workmen under them were to stand for only four hours. The whole responsibility of each district lay upon the person in charge at the time, and they had another man on the surface to whom each of those parties applied for men. He did not think the person in charge of the whole should be bothered seeking for men. Therefore, he would advise the appointment of a second man on the surface to whom the parties could apply for men and material. After they had done that, events as the explorations progressed might make them alter their plan, but he thought in the case of Udston they followed out the plan laid down very satisfactorily. Speaking of the explosions in which he had been interested and had advised in both in England and Scotland, he could not call to mind any occasion where the work got on more smoothly, and the arrangements worked more effectively. He did not think he could advise anything else. Of course, as to the appearance of things after the explosion, there was really in the Udston case nothing to be afraid of. That was to say, with ordinary caution people went steadily on. If there was anything like fire underground, as Mr Hogg had said, there would be arrangements made for that. He did not think they could lay down any particular rules—they must be guided by circumstances.

Mr GILCHRIST said, for the information of Mr Dunn, there was a man in charge on the surface at Udston; but he should have been appointed earlier. There were really two taking charge on the surface, but they were appointed after those placed in charge underground which was a little late in the day. As to

notes, these were taken of all indications likely to throw light on the explosion. All the explorers took these notes, and they were collected and some of them acted upon afterwards.

Mr RALPH MOORE said it was of the greatest importance that notes be taken of the position where the bodies were found, and also of any indications of force and points where gas was formed, and the appearance of the roof and sides as to signs of burning. That was very thoroughly gone into—in the first place, by the heads of the explorers and their assistants; and, in the next place, by the police. The numbers were placed upon the bodies, and these, again, were checked by the police and descriptions given of them. The result was they had a most complete plan, shewing the position of the bodies, and also the indications of force in every way. He hoped some day to show them the plan.

Mr DUNN said he was at Barnsley very shortly after the very serious explosion there, by which three hundred odd lives were lost. The arrangements there were very complete. The pit top was in charge of a head viewer, with several engine wrights beside him, who put down the different kinds of material, and in proper quantities. As had been remarked by Mr Gilchrist, it was important not to send too much of anything in any one tub or any one load, but yet in sufficient quantities for the part at which they were required. In regard to the ventilation, even at Udston a water-fall would have been a very important matter in the down-cast shaft. He had proved the sufficiency of a water-fall, often in similar circumstances, and he would counsel any one who might be in that unfortunate position to at once have recourse to a water-fall. It did not require a large quantity of water if let fall in the centre of the shaft. It would take down an additional quantity of air more than could be expected from the ordinary means of ventilation. There was another point he would call attention to, viz., with every squad of men have a competent joiner. He knew that many believed that no man was better at this sort of work than a pitman, but he would have the greatest confidence in men trained to the handling of tools being more expeditious at the work than men who were not so trained.

Mr GILCHRIST, in reference to the Fleuss Apparatus, said it might be as well to remind the members that the Institute appointed a committee to see after this matter at one time, and he knew one member of the Institute offered to provide one of them. He did not suppose the apparatus could have been used at Udston, although it was noticed that at one point the brattice had been on fire. Had that remained burning for some time, there could be no doubt they would have been at a loss for some such apparatus for carrying on the work. As to Mr Dunn's water-fall, at Udston the fan was uninjured, and he did not think there was any need for a water-fall.

The CHAIRMAN closed the discussion, and moved a vote of thanks to Mr Hogg, which was heartily accorded.

The following paper on "Ackroyd's & Best's Safety Lamp Cleaning Machine" was then read:—

ACKROYD & BEST'S MINERS' SAFETY LAMP CLEANING MACHINE.

By Wm. Best.

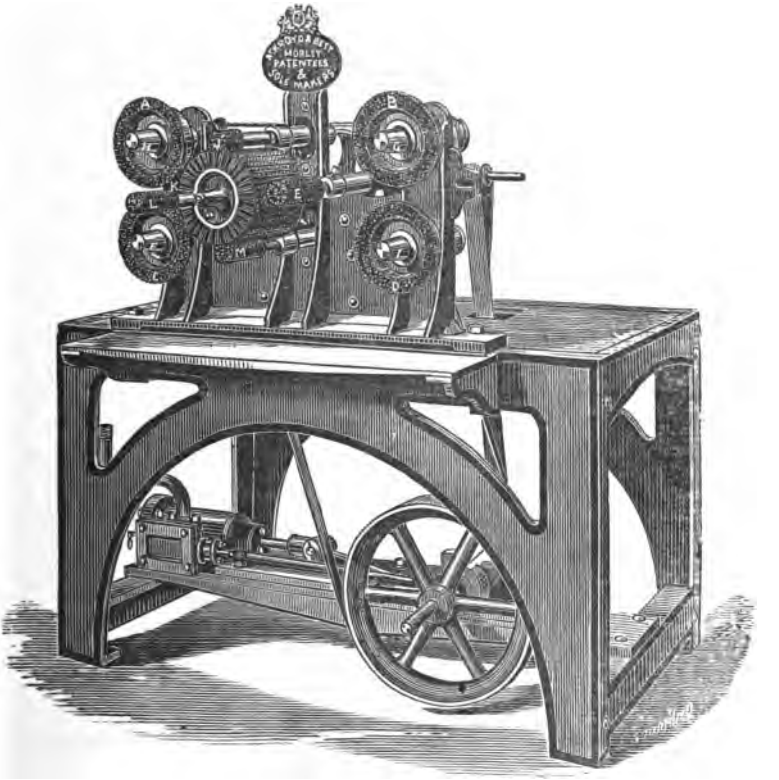
The subject of cleaning lamps by mechanical means is one which the makers of this machine have had under consideration for the past ten years. They were convinced that there was a more effectual and economical method of cleaning the miners' safety lamps than by hand, and consequently this machine has been introduced into the market.

At collieries where the safety lamp has not been cleaned by an efficient staff of workmen, it has been and is even now at some places taken home by the miner, and left in the hands of his family to clean and to be put together by them ready for use the next day.

Where the lamps are cleaned on the premises, there are, in some instances, some of the most extravagant methods used in employing more hands than are required; while, on the other hand, the writer has found instances where two or three men are expected to clean four or five hundred Clanny lamps. At such places it is no uncommon thing to find the top and bottom gauzes fast together, owing to their not having been taken out regularly, in order to be thoroughly cleaned and examined before being replaced; and the part of the bottom gauze which is most likely to be damaged by the action of the flame, is sometimes not examined at all. It has been no uncommon occurrence to find the top of the bottom gauze burnt to such an extent that, by squeezing it together between the finger and thumb, the wires of the gauze break in pieces. Some lampmen, on being asked what was the cause of its being in that condition, have replied that it was impossible to get through the amount of work so as to be ready for the men next morning, consequently they had to do it the best way possible. Such lamp cleaning will not stand the test on being brought to daylight. But it was not owing to any of these systems having been practised at Morley Mains Colliery that the present machine was invented. Our gauzes were taken out regularly

and cleaned and examined every day; but the brass work was only wiped over with waste, leaving a black tarnish. Afterwards that part of the lamp round the light was polished by hand with wonderful effect—the polished brass giving great assistance by reflection. It was soon found that it required much more time and labour than could be afforded, with the number of hands then employed. But it was determined to have the lamps efficiently cleaned. The lamps at that time were a mixed class of Davy, Stephenson, and Clanny. The Davy suffered much from careless usage, as it could be held in the workman's hand at any angle without any danger of breaking a glass; so that, unless the tube fitted well, oil would leak out and run on the gauze, which had to be either steamed or burnt out. Now, with the machine, sewn gauzes can be soaked in oil, and then be thoroughly cleaned without fire, which burns out the nature of the wire—or steam, which tends to rust the whole gauze. In hand cleaning the oil vessel is screwed off to be refilled. A piece of wood or iron the required shape is then used to screw out the glass ring, which is a slow process; while, with the machine, a key is bolted on the cleaner's table, with this the operator slackens the glass screw, and then places his lamp on the end of a conical spindle, which is running at a high speed, and instantly twists out the ring in less than half the time required by hand. The hand cleaner next takes out the glass and places it on the table in front of the screw ring to keep it to its own lamp; he next takes out the gauzes and places them opposite the glass, and puts down the frame of the lamp. There are as many persons employed as there are sections or parts in the lamp, each one cleaning a part and replacing it on the table, until about forty or fifty lamps have been gone through; then they are put together. While, with the machine, the cleaner takes out the glass ring, as mentioned before; next he takes out the glass, cleans it; then the gauze, brushes it with the centre brush, allowing it to circulate in his hand for a second or two, then places it on a brush spindle. While the gauze is being brushed, he is polishing the brass frame. When it is finished the gauze is quite ready for being replaced in the lamp, not put on the table and then have to

be taken up again, as in the case of hand cleaning. Each part is cleaned as it is taken out, so that each man cleans every part and finishes his own lamp. This system dispenses with the vast amount of repetition in the handling of the various



Ackroyd & Best's Patent Safety Lamp Cleaning Machine and Engine combined.

parts of the lamp. The machine is fitted up with two spindles on each side, upon which are fastened two brushes for brass polishing. Those spindles revolve at over 1000 revolutions per minute, and revolve in the opposite direction one to the other for the purpose of taking out and replacing the glass screw ring as previously described. A mixture of water and Spanish

white is applied to the bottom brush, which instantly removes all the tarnish from the brass work. The top brush is kept dry, and is used for finishing only, producing a beautiful polish. The small brush at the centre of the large barrel brush is for cleaning the inside of the gauze. The gauze is then put on, one of the brushes running in contact with and by the friction of the large brush, and left there to clean. This method has a wonderful effect. The barrel brush, while revolving, is worked horizontally at the same time by a cam motion, which is fixed behind the machine. The gauze brushes which hold the gauze against the barrel brush can be adjusted as the brushes wear away. These combined motions brush the gauzes in both directions with great effect. Two men can be constantly working, and clean from forty to fifty lamps each per hour, or five hundred gauzes alone with one man. A saving of at least thirty per cent. in labour and over fifty per cent. in the gauzes is effected. Whenever the instructions are enforced and workmen willing to learn, the machine has never failed to give the utmost satisfaction. The price of the machine may appear to be large, but, considering the saving effected and the beautiful condition of the lamps, the price is moderate. Wherever the safety lamp is used and cleaned efficiently by hand, by the introduction of the machine a saving equal to the price of the machine can be effected in the first year. Lampmen who have now got thoroughly into using the machine, say that they would not go back to the old way.

Mr RALPH MOORE said the great thing was to ensure that the lamp was put properly up after being cleaned.

Mr BEST said there was no great difficulty in putting the lamp together. They claimed for their machine that they could do more work and that more efficiently with two men than with three men with hand labour.

Mr DUNN—You do not profess that your machine will do away with a thoroughly competent man to examine the lamps?

Mr BEST—Not at all.

Mr COWAN—You never can dispense with a thoroughly competent man in the inspection of the lamps.

Mr HASTIE asked how many men would be employed with the machine to keep 500 lamps per day in order?

Mr BEST—Two cleaners and two passing and filling the vessels.

Mr R. STEWART—What is the cost of the machine?

Mr BEST—The price of the machine is £35, engine and everything complete.

Mr RALPH MOORE—I should like to know when are the lamps examined and by whom?

Mr BEST—The individual who examines the gauze is there when the lamp is given out next morning and is responsible for the lamps going into the pit all right.

Mr COWAN—As I take it, the man calling himself foreman of the squad is the "thoroughly competent man."

Mr BEST, replying to further questions, said the machine was not intended to do away with an examination of the lamp. The same individual who was responsible under hand cleaning took the responsibility under the machine that the lamp was in a safe condition.

Mr JAMES GILCHRIST said Mr Best seemed to take for granted that in hand cleaning the gauzes were not cleaned, and that by introducing the machine they would be cleaned. If the lamp-trimmer was a lazy man at hand cleaning the chances were he would remain so.

Mr MOORE—Granted you have an efficient man, does this machine enable you to detect imperfections in the gauze any more readily than a careful man would do with a brush?

Mr BEST said his contention was: the fact of the gauze being fastened together was a proof that the lamp had not been taken apart and cleaned. With the machine they could not clean the gauze unless by taking it out and examining it.

Mr BLYTH said the reader of the paper cast a slur on their lamp-cleaners. Never, in his experience, did he see two gauzes sticking together, and he was of opinion a lazy man in hand cleaning would be found to be lazy with this machine also.

Mr RALPH MOORE said that was precisely what he intended to bring out. There was no doubt machinery was very good and very desirable as far as it went, but they should be careful not to delegate any cleaning to machinery which would prevent that

thorough examination which a competent man cleaning lamps must exercise. He was very anxious that his view on that subject should be taken, viz., that lamp cleaning by hand gave opportunities for examination which cleaning by machinery might give but which he had not yet seen it give. He did not say a word against the machine, but he was rather inclined to agree with Mr Blyth that there were very few negligent men at such work. If there was a possibility of such a thing he did not think this machine would remedy it very much. He quite went in with machinery as far as possible, but he was very anxious that the lamp should be carefully examined and all its parts seen, and examined by competent men.

Mr DUNN said it did not appear to him from its appearance to be a very expensive machine. This was pre-eminently an age for economising, but in this case they certainly must have efficiency with economy. He thought those gentlemen who were using a large number of lamps would be disposed to look favourably on the machine.

The discussion was then adjourned.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON,

10th November, 1887.

JAMES S. DIXON, Esq., President, in the Chair.

About 40 members were present.

The minutes of the former meeting were read by the Secretary and confirmed.

The following were elected by ballot as ordinary members:—

WM. WALKER, Cadzow Colliery, Hamilton.
JAS. WARDROP, Ormiston Station Colliery, Ormiston.
JAMES A. HOOD, Whitehill Collieries, Rosewell.
YOSHITADA OKI, Takasima Colliery, Magasaki, Japan.
JOHN GRAHAME, Lightshaw, Muirkirk.

The following discussion then took place:—

DISCUSSION OF MR BEST'S PAPER ON "ACKROYD & BEST'S LAMP CLEANING MACHINE."

The SECRETARY stated that he had been desired by Mr Best to say that in his paper he did not attribute the cause of the gauzes being fast together to the laziness of the cleaners, but to their not having sufficient time to clean the quantity effectually.

The PRESIDENT asked if the machine had been tried anywhere since last meeting.

The SECRETARY said Mr Best had mentioned that he expected to have a trial of it made at Cadzow Colliery, but he did not know whether this had been done or not.

Mr MICHAEL ROSS said the machine was working there.

The PRESIDENT said he had seen machines something like this one in visiting different collieries. He did not know if they were this particular machine or not, but they seemed to do the work. It was very much a question of how many lamps they had to clean. If labour could be saved, the machine should be adopted.

Mr HASTIE—Mr Best admits that four men are necessary to clean 400 or 500 lamps.

The PRESIDENT suggested that the discussion should be adjourned to obtain the details of the trials at Cadzow. It was an interesting subject, and if they could get light thrown on it by one of their neighbours, they would be better able to judge of the machine.

This course was adopted.

The following paper on "Proposed Schemes for Keeping Mines Clear of Inflammable Gas" was then read by Mr GILBERT M'PHERSON, Jun. :—

PROPOSED SCHEMES FOR KEEPING MINES CLEAR OF INFLAMMABLE GAS.

By Gilbert M'Pherson, Sr., and Gilbert M'Pherson, Jr.

It has been clearly shewn by the experiments and investigations of the Royal Commission on Accidents in Mines that it is next to impossible to get a thoroughly safe safety lamp; and even although a perfect lamp is at last invented, as long as gunpowder or other explosive is used for blasting, and as long as a reckless miner can carry matches with him, so long will explosions occur, unless some means can be devised for keeping mines free from the presence of inflammable gas.

It is proposed in the following remarks to describe how this may be effected by two schemes:—First, By draining the coal of its gas before it is worked out while the rooms or bords are being driven. Second, By removing the stoops according to a plan by which the goaf is kept clear of inflammable gas. The first, to our knowledge, has never been tried, but the second has been successfully tried in one instance.

Carburetted hydrogen gas or firedamp has been evolved, according to scientific authorities, while the coal-forming materials were undergoing decomposition, and is now simply stored up in the pores and cells in the coal, which, owing to its open porous nature, and the fact that the gas is often strongly compressed, can contain a large quantity.

When a fresh surface of coal is laid bare, gas immediately begins to exude from it in greater or less quantities, according to the porosity of the coal and the pressure of the confined gas, but after the coal stands exposed for some time the gas becomes exhausted, and ceases to appear till more coal is taken down and another fresh surface is exposed.

In the first scheme it is proposed to exhaust the gas from the coal, before it is worked out, by artificial means (the ordinary system of ventilation being still employed) so that it can give out none while being taken down.

This is to be effected by carrying down the shaft from the surface a small column of pipes, and laying throughout the mine a system of gas-draining tubes, a small branch being carried into

every working place. The column of cast iron pipes in the shaft would require to be about 3 inches diameter, and in all likelihood $1\frac{1}{2}$ inch malleable iron tubes in the main roads, and tubes of $\frac{1}{2}$ inch diameter or even less in the working places would be found sufficient.

In the centre of each working place (Figs. 1 and 2, Plate III.) a hole would be drilled to the depth in each case which would determine for each particular seam, probably about 8 or 9 feet and 2 inches or so in diameter. Into this a tamping block or plug (Fig. 3, Plate III.) would be inserted and screwed up so as to make it air tight, and a connection would then be made between it and the draining tubes by means of a small indiarubber hose distended with wire, united to the tubes and tamping plug by union couplings of the simplest description.

On the surface an air pump of suitable dimensions would require to be erected and connected with the column of pipes in the shaft.

When the whole connections were made and the air pump started, the air contained in the holes drilled in the coal would be exhausted and a partial vacuum formed, when the gas in the surrounding coal would be swept into the drain pipes owing to the atmospheric pressure forcing the air through the pores of the coal, the air in its passage becoming charged with inflammable gas.

Probably one hole in the centre of each working place would be found sufficient, but experience would shew if more were required; and it is possible that flank boreholes at intervals might also be needed.

Owing to the light specific gravity of firedamp, it, as is well known, collects near the roof, but more especially in holes or excavations in the roof, or close to the face, if the working is being driven to the rise. It is proposed, in order to remove the gas thus collected, to have a very small branch pipe of $\frac{1}{8}$ in. dia. or even less connected with the drain pipes, having the open end placed at the highest point of any excavation or opening in the roof caused by a fall or otherwise, as shown in Fig. 1, Plate III. Also, in all places working to the rise, or perhaps even in all working places, a small branch pipe could be kept always at the

highest point near the face, where if gas collected it would be sure to suck it in. This would effectually prevent small explosions, which, though not in themselves very dangerous, often propagate flame into large bodies of gas and so cause great explosions; or they may be the means of raising the dust and causing a dust explosion. This would also tend to keep the atmosphere free from inappreciable quantities of firedamp, which would greatly lessen the risks of having dust explosions.

The gas-exhausting process could be going on continually in the working places except when the miner was bringing down his coal, when the plug and flexible tube would require to be detached, but after the coal was down these could be again adjusted in what remained of the hole, and this could be deepened at night by the fireman or other person appointed for the purpose. The tubes could be so arranged that they would not interfere with any of the miner's movements in his place.

The gas drain pipes might also be used in dry dusty mines for watering the dust. At suitable intervals taps could be fixed; and water being run in at the surface would be distributed all over the mine; or perhaps taps could be dispensed with and the water allowed to find its way to the face only, where it is most needed for damping purposes. Taps would however always be required fixed in suitable positions to empty the pipes.

This drenching process could be easily carried out when needed.

In the second scheme it is proposed to remove the stoops after the system shewn in Plate IV. When the back of the estate or district is reached and stooping operations become necessary, instead of beginning to remove stoops in the usual method, an air-course is first arranged round the district and this air-course is maintained till every stoop is removed. How this is done will be best understood from the plate. Very little coal is lost, as very light stoops do on the side of the air-course, these not being more than 5 or 6 yards wide.

In the stoppings on the side of the main air-course, which are of the usual description, three-inch rhones or wooden tubes are built in at suitable intervals; and by means of these miniature air-courses a quantity of air sufficient to ventilate the goaf is constantly circulated.

One of the main features in this plan was the redding on the high side of the goaf of two or three places (three are shewn in plate) up along the broken metals, after the first break, to a height of thirty feet or so, and splitting the air in the air-course by means of a screen, thus sending a quantity up round these places. These being by far the highest points in the whole working, any gas that escapes into the higher parts of the goaf, owing to the broken state of the metals, is sure to find its way up to them, where it is at once swept away by the current of air. A small sucking tube connected with the gas drain pipes might with advantage be placed here.

This method was tried in a mine belonging to Messrs John Galloway & Co., at Hurlford, and thirty acres of stoops were successfully and safely removed. No explosions of any kind occurred during the removal, and indeed so complete was the absence of gas, that it was thought it had pined off, till on stopping the ventilating fan on one occasion to repair the shaft, the whole workings filled to the bottom in less than twenty-four hours with inflammable gas. It took the fan two days to completely drain it off; but this was the last occasion on which gas was seen in this working.

There can be no doubt that in keeping the goaf free from inflammable gas a very great danger is removed from a mine, as in many instances this contains a large body of gas, which may be driven out by a fall, or may expand by a lowering of the atmospheric pressure, or it may be exploded by a small explosion or by a blown-out shot, with a disastrous result.

It is obvious that the exhausting plan can be applied to long-wall as well as stoop-and-room workings, and small sucking tubes could be placed in cavities in the roof in the same way—one of these, in particular, could always be placed at the point in the roads where the "brushing" ceases to be taken down, which is usually a place where gas accumulates.

Regarding the effects of the exhaustion of air from a surface of coal, the following interesting experiments, which have fallen under our notice since the above scheme was devised, and which were described in 1876 by Mr Hall, one of Her Majesty's inspectors of mines, are worthy of careful attention. They are

described at page 35 of "Reprint of Final Report of the Royal Commission on Accidents in Mines," and are as follows :—

"An iron tube, four inches diameter and four feet long, was tamped into a bore-hole eighteen inches deep, and a pressure gauge was attached to it by a side tube close to the face of the coal. In the tube was an air-tight piston initially at the bottom of the bore-hole. When this piston was withdrawn there would be a considerably diminished pressure on the twelve or thirteen square inches of coal exposed at the end of the hole, and if gas only entered the tube at its normal rate of escape, the gauge would indicate the formation of a partial vacuum as soon as the piston passed the junction or the side pipe with the main tube. In one experiment in the Bastian seam, a slight diminution of pressure was thus produced, but almost instantly the pressure due to the gas, or to air which had been drawn into the coal and became highly charged with gas, was sufficient to balance the atmospheric pressure. When the piston was forced back into the tube, the gas was driven back into the coal and escaped from points, probably small crevices, spread over an area of the face to a distance of from four to five feet from the bore-hole. When lighted, this abnormal issue of gas burned as tongues of flame distributed over the face."

"Similar experiments were tried in the Wigan Nine-feet, a very fiery seam, and the Pemberton Four-feet, a seam considered to make very little gas, but in neither case did the gauge show any diminished pressure on the tube; the gas at atmospheric pressure followed up the piston as fast as it could be withdrawn."

Apart altogether from the question of safety, which is the question of paramount importance, there is no doubt it will be quite possible to utilize the gas collected by this process of exhaustion, by storing it at the surface, and applying it either for lighting or heating purposes. In the case of an explosion, we get some idea of the immense store of energy in fire-damp, by witnessing the destruction it causes; and when we consider that the body of gas which possessed this large amount of energy was sometimes collected in a few hours, we can estimate to some extent the large quantity of useful work it could perform if only means were at hand for collecting and applying it.

If the gas collected could even be utilized so far as to pay the cost of the application of the system, a great point would have been gained.

In conclusion, we may be allowed to remark that had half the scientific and practical ability which has been displayed in the perfecting of apparatus for working amongst fire-damp been directed to getting rid of the gas altogether, an explosion by this time would have been a less frequent occurrence.

DISCUSSION.

The PRESIDENT remarked that the paper, being accompanied by illustrations, was one that required some study before discussion could take place upon it. However, members might wish to make some remarks.

The SECRETARY asked what was the depth of the pits at Hurlford where the stoops were taken out.

Mr M'PHERSON—About fifty fathoms.

The SECRETARY said it struck him that the distance of five yards of a stoop to be left for the protection of an air-course around the stooped area was rather a short distance. The experience around Hamilton, he ventured to say, was very different from that. It appeared to him, so far as the exhaustion of gas from the coal face was concerned, that this plan might to some extent effect the purpose in a seam giving off a moderate quantity of fire-damp, but he feared those pipes would be totally inadequate to cope with any outburst, even although it were an outburst of no very serious nature. There would be outbursts which it would be quite inadequate to cope with, so far as he could see, and he questioned if it would even be effective in the case of moderate blowers.

Mr ROBERT L. GALLOWAY said, in a fiery seam, those holes could not be bored without a safety lamp, because the gas would come out with such force that the miner would require to be protected.

Mr HASTIE asked if Mr M'Pherson could give any idea as to the cost of the pipes.

Mr M'PHERSON—No.

Mr HUGH JOHNSTONE suggested that Mr M'Pherson might add to his paper a detailed section showing the nature of the roof and pavement overlying and underlying the coal. This would affect the question of how long the waste beyond the face would remain open, and add to the value of the paper.

The PRESIDENT said there was one thing he was glad of, viz., that the experiment of leaving the air-course round the working seemed to have been an actual trial. He was of the same opinion as Mr Barrowman, that in most places those stoops would require to be much stronger than what was indicated here, but these were matters they would consider and discuss at next meeting.

The discussion was then adjourned.

The following paper on an "Air-agitated Coal Washer" was then read by Mr James F. Waldie :—

AIR-AGITATED COAL-WASHER.

STEWART-WALDIE PATENT.

By JAMES F. WALDIE.

The machine which is the subject of this paper, had its origin, like many other appliances, in the necessity more than ever required in these times of trade depression, of doing a maximum of work at a minimum of cost. About two years ago it was found that new outlets were needed for the dross produced at the pits of the Legbrannock District Collieries Company (Limited), and washing naturally suggested itself. A trough washer was erected as an experiment, but found too costly to work, besides not dealing satisfactorily with any quantity, and we were compelled to look for some other means of doing the work.

What we needed was a machine able to wash properly up to 200 tons per shift; to be fitted on a pithead, and arranged to wash the dross coming direct from the pit, as well as from waggons; to screen up to five sizes, cleaning the smallest for coking, and last, but not least, to be cheap in first cost and in working. Keeping these points in view, and finding no machine which we thought we could depend on for them all, it was resolved to try what we could do ourselves. Mr Stewart having suggested the mixture of air and water, which is one of the features of the perfected machine, we proceeded to work out his idea as follows:—About 50 feet of old iron piping, 2½ins. in diameter, was coiled horizontally about 24ins. above the bottom of the egg-ended portion of an old boiler, the two ends of the piping being connected with a pump from which air and water were forced. This arrangement did fairly good work for some months, but did not distribute the pressure equally, whilst coal was apt to get down along with the dirt, through the spaces between the coils, and the coils themselves got choked with mud, which was difficult to clean out. The pipes and old boiler were therefore replaced by the pressure chamber and washing vessel to be afterwards described.

I may be excused having thus briefly sketched the history of the machine, as it naturally leads up to the description of it, which I propose to divide into two parts—one describing the machinery, and the other the process of washing.

The machine is placed on the pithead, rather above the level of the scaffolding, as will be afterwards shown (see Plates V. and VI.) The washing vessel (A) is made of $\frac{3}{8}$in. boiler plate, and is 5ft. dia. at top, the bottom being flat, except where it is broken by being carried down 2ft. deep by 2ft. dia., to form the lower portion of dirt chamber (B). At the bottom of this dirt chamber again is placed a ball valve (C), kept in place by a spindle (D), working perpendicularly by a guide placed 18ins. or so above the valve, or in a space bored out in lower portion of perpendicular shaft as shown in the drawing. The ball is attached outside the washing vessel to a lever, the handle of which can be worked either by hand or automatically.

Round the bottom of the washing vessel another chamber (F) is formed 18ins. deep, the top of this chamber being 21ins. from top of the washing vessel, and consisting of a steel plate $\frac{5}{8}$in. thick, the plate being bevelled 5ins. inwards and bored with 320 holes. This chamber is calculated to stand a pressure of up to 100lbs. per square inch, and a pipe from it connects to an ordinary pressure gauge (G), whilst at the side is a man-hole to allow of its being easily cleaned out. Into each of the 320 holes on the top plate of this pressure chamber is screwed a brass nozzle (H), conically bored, so that at the top the aperture is barely $\frac{1}{16}$in. diameter, and at foot $\frac{1}{2}$in. diameter. These plugs are screwed into the holes from inside the pressure chamber, and are of such a length that when they are flush with the top of top plate, there is $\frac{7}{8}$in. left below the plate. The length of them may be somewhat increased with advantage.

The top of the washing vessel is 32ft. above the top of the rails in the sidings below, and the bottom of the dirt chamber being $4\frac{1}{2}$ft. above the level on which the output from the pit lands. The ordinary pithead staff can attend to the taking away of the dirt. The engine and pump are not, at Legbrannock, what we should have erected had we not been using up what material we had in stock, the pump being driven by the fan engine.

I shall therefore describe the more compact arrangement which would be preferable for any new fitting, for say 200 tons daily.

An upright engine, 12ins. cylinder by 24ins. stroke, is placed with its bottom close to and nearly level with the top of the washing vessel. The piston rod of this engine is carried down to work an 8ins. double acting pump, placed on or near the ground, and connected with the pond. On the pump are placed two brass cocks, fitted with valves to allow air to enter, but preventing the escape of water, and also allowing the quantity of air to be controlled. The air and water thus brought together in the pump are forced by it up to the pressure chamber, a safety valve and lever (P) being, however, placed on the pipe close to the chamber. This valve enables the pressure to be regulated, and its overflow is carried up to the shoot leading from the elevators to the washer, where the water is useful in keeping the shoot clear, and at the same time in softening the dross before it reaches the washer.

Returning to the engine. The upper end of the piston drives a shaft carried above the top of the washer at a height of nine feet, which shaft drives the elevators, and also a perpendicular shaft, reaching down in the centre of the washing vessel to within $\frac{1}{8}$in. of the top plate of the pressure chamber where there are fixed on it four arms and from them again two pieces of iron, set at an angle with the arms and curved to run close to the lower angle of the washing vessel. On the perpendicular shaft is also fixed, about 9ins. above the top of the washing vessel, a pinion, driving the circular screen, and on it also is fixed at the level of the washing vessel's top an iron collar, 24ins. diameter. In the drawing is also shewn an iron hood (K) reaching down the shaft (L) from the iron collar (J) to slightly above the arms (I). This hood we do not find necessary at Legbrannock, but it might be an advantage in the event of rapid working of the ball valve emptying the dirt chamber to such an extent as to cause coal to slip into it, the hood tending to prevent this by throwing the dross outwards as it enters the washer through the iron collar, as I shall afterwards describe.

The elevators, as above stated, are driven off the main shaft by a pair of pinions placed three feet beyond the perpendicular

shaft. These elevators, at Legbrannock, consist of a chain, 85½ft. in length, of nineteen buckets, each holding about one cwt., but they are too large, and a smaller size would be preferable.

The engine goes 100 strokes per minute, the perpendicular shaft, geared 5 to 1, goes 20 revolutions, and the elevator driving-pinion geared 25 to 1 of the engine goes 4 revolutions per minute.

Having described the machinery, — which will, however, be better understood by a study of the plans,—I will detail the process of washing, explaining, however, that the arrangements for handling the washed material must necessarily vary with different requirements.

The dross at Legbrannock is got either direct from the pit or from wagons. In the first case it falls into the well (which extends under two lines of rails) from the Billy-Fairplay hoppers ; and in the latter case it is tipped through the end doors of the wagons, which are lifted on end by a simple hydraulic arrangement, consisting of an old 7½ins. dook pump standing perpendicularly, and fitted with a plunger. This pump is connected with an old boiler testing pump, by a 1in. pipe and the whole arrangement is fitted on a bogie running on rails, fixed under the pithead scaffolding, parallel with sidings below. A man goes up by ladder to the bogie, shifts it to suit whichever way the end of the wagon requires, attaches the chains from the top of the plunger to the wagon, starts the pump and lifts the wagon to the height needed, from which it is lowered again by allowing the water to run from under the plunger back into the little reservoir attached to the testing pump. This arrangement is, of course, not strictly part of the washing apparatus ; but as an adaptation of old material (often found spare about a colliery) to useful work, it may prove of interest to some.

The dross and well we keep full of water, finding the elevators feed better when it is so, and the moist dross appears to be more easily washed than when the washer gets it quite dry. The elevator buckets empty themselves at the top into an iron hopper, and into this hopper is led the clean water from the overflow at valve (P) already described, which water still further softens the mass of the dross, and also—what is more important—assists it in running down the shoot to the iron

guide, the shoot being thus kept clear, no more than one bucketful being in it at once. The iron guide (J), revolving as already shown with the perpendicular shaft (L), receives the dross from this shoot, and leads it down to the centre of the washing vessel (A) where it is caught by the current created by stirrers (I), and by this current is carried round and up, exposed to the action of the jets of air and water coming from the pressure chamber (F) through the 320 conically bored plugs already described. Under this action the dirt or heavy material is separated from the coal and falls down to the dirt chamber (B) where it is drawn away as required through the ball valve (C). When the washer is first started the dirt chamber, if empty, fills with dross, which is drawn out as the dirt accumulates on the top of it, and emptied into the well to be rewashed. The whole quantity of dross thus treated should not exceed two or three cwts., and thereafter the dirt itself fills up the dirt chamber, the top assuming a convex shape as it is drawn away from below.

The cleaned coal is led away from an overflow (M) at the top of the washing vessel, together with the water, to a circular revolving screen. At one side of the overflow, and in washing vessel, is fixed a plate (N) 11 inches deep by 3 feet long, which catches any wash caused by the circular current, preventing any stones or heavy material, which, but for it, might be thrown over by the wash, from reaching the overflow. It may be noted here that as the dross feeds into the washer at the rate of 8 cwt. per minute, and the stirrers make 20 revolutions per minute, it takes $2\frac{1}{2}$ revolutions of the stirrers to throw out 1 cwt. of dross, and taking the surface of the top of the pressure chamber at 16 square feet, it may be assumed that in theory every hundredweight of dross is exposed while in the washer to the action of 40 square feet of washing surface, or in other words, to 800 jets of air and water. In practice, we believe this to be nearly borne out, the course of the dross passing through the washing vessel being very regular.

The pressure and air supply will vary with the quality of dross under treatment, but we generally work at from 35 to 40 lbs. per square inch, the pump going 40 strokes per minute, half on air and half on water, and that at Legbrannock being a 7ins. double

acting pump we have 36 tons of water per hour, or about 1¾ tons of water to one ton of dross. Less than this might suffice, but having enough water we prefer to let the dross have the benefit of it.

I may say here that every part of the washer keeps almost quite free of accumulation of dirt. It never chokes, and after nine months' work we found only two inches of smudge on the floor of the pressure chamber. The brass nozzles seldom plug, and when they do are easily cleaned by putting a wire down through them. The water at Legbrannock comes from the pit and is fairly clean.

The washed material is, of course, sized to suit the demand, the gum being carried away by the water to a series of tanks made from an old boiler, which are placed perpendicularly in front of the boiler fires. As the gum sinks in the tanks it is drawn off through valves by the fireman and falls into the firehole, or it is taken away for coking, the water being taken to filtering ponds, on leaving which it is ready for use again if required.

The cost of the machine being naturally a most important point, I may be expected to give particulars of it, but can only say that, so far as our experience goes, a machine to wash 200 tons per day of 10 hours, should be fitted up, including the foundations and woodwork, but exclusive of boiler power, for £400, and it may be less. This is for all new machinery, arranged on a pithead.

The cost of working I can give in more detail, and for 200 tons daily, for 300 shifts per annum, it should be as follows:—

Engineman, also assisting to take away dirt, ...	3/8 per shift.
Labourer at dirt, ...	2/ ,,
Depreciation and interest on £400, at 15 % per annum,	4/ ,,
Steam, if from ordinary pit boilers, say equal 1 ton gum,	2/ ,,
Oil, waste, &c., ...	/6 ,,
	12/2

or ·73d per ton per shift. This is for dross direct from the pit. If dross is emptied it will of course add to the cost. The trimming and shifting of wagons is no more than if the dross goes direct

into the wagons without washing. The dirt may also fall direct into wagons in place of hutches, and other details may vary, affecting the costs.

The machine may be enlarged by increasing diameter of washing vessel or by duplicating it, the same set of machinery serving if proportionately increased in size, whilst smaller sizes can be arranged to be worked by the ordinary pithead staff.

The effectiveness of the machine is best seen in its actual working, but I have endeavoured to reduce the results to figures in the tables which follow this paper, and I may add that we have every reason to be satisfied with the thoroughness with which the Legbrannock machine cleans the dross. We had, of course, difficulties at first, but latterly the washed material has been much approved of.

I think it right to add that I undertook the preparation of this paper at Mr Stewart's request, as it was he who wrought out most of the practical details of the machine. Our joint endeavour has, however, been to produce an appliance adapted to the requirements of the collieries with which we are connected, and the result is at least a practical, and not merely a theoretical machine. We will welcome any fair criticism; and now that we have, somewhat reluctantly, made a start, we hope that other members may continue with papers on other coal-washers, and so form to some extent a book of reference on the subject, of which there is none at present, so far as I am aware.

Table showing Pressure of Half-air and Half-water required to Force the Agitation through Various Depths of Water in Washing Vessel.

Depth of Water on the Top of Upper Plate of Pressure Chamber.	Agitation Reaches Surface of Water when Gauge at
3 inches.	9 lbs. per sq. in.
5 ,,	12 ,, ,,
7 ,,	17 ,, ,,
9 ,,	26 ,, ,,
11 ,,	45 ,, ,,

Table showing Quantity (by Percentages) of Different Kinds of Coal Washed and Quantity of Dirt taken out by Machine in Regular Washing.

Period Ending	Kinds.			Dirt.
	Upper Drumgray.	Lower Drumgray.	Lower Drumgray and Virtuewell Mixed.	
January 8.	10 per cent.	36 per cent.	54 per cent.	8·35 per cent.
February 19.	19 ,,	81 ,,	—	5·84 ,,
March 5.	24 ,,	66 ,,	10 per cent.	6·79 ,,
,, 19.	14 ,,	41 ,,	45 ,,	7·12 ,,
April 2.	13 ,,	47 ,,	40 ,,	6·60 ,,
,, 16.	12 ,,	44 ,,	44 ,,	8·62 ,,
,, 30.	5 ,,	32 ,,	63 ,,	7·43 ,,

Table showing Quantity (by Percentages) of Dirt in Several Descriptions of Coal Washed Experimentally.

Description of Coal.	Dirt.
Lower Drumgray, - - - - - - - - -	4·20 per cent.
Lower Drumgray, Large Screened Chirls, - - -	3·36 ,,
A Very Dirty Virtuewell (not that above referred to),	29·89 ,,

Table showing Result of a Series of Tests for Ash in the Dross Before and After Washing, as made at the Pit, with a view to approach results in Actual Practice, rather than those which might be got by a Laboratory Analysis.

Kind.	Ash.
Dross (mixed), before Washing, - - - - -	11 per cent.
Small Dross, after Washing, - - - - -	4½ ,,
Peas, after Washing, - - - - - - -	4 ,,
Second Nuts, after Washing, - - - - -	3 ,,
Third Nuts, after Washing, - - - - -	2½ ,,

DISCUSSION.

The PRESIDENT said he did not think Mr Waldie had dwelt sufficiently on the advantages of the air in connection with the washer. This seemed really to be the principal novel feature in Mr Waldie's arrangement.

Mr ROBERT STEWART, the other patentee, said the only thing he could say about the air was that it assisted in keeping the dross in suspension, and enabling it to get a proper chance in revolving round the jets.

The PRESIDENT asked if water going up through the jets would not have very much the same effect.

Mr A. M. GRANT gave it as his opinion that it would.

Mr HUGH JOHNSTONE said perhaps Mr Stewart would say if any experiments had been made with the machine without the air and with pure water agitation.

Mr STEWART said they had never tried it without the air. When their dross was difficult to clean they put on more air, and if it was clean they gave it less. The air cushions along with the water, assisting the pumping greatly.

Mr GRANT—Do I understand that there is water force acting along with the air through that same pipe?

Mr STEWART answered in the affirmative.

Mr GRANT—Then that must be clean water.

Mr STEWART—It is the water saved from the washing of the dross after it has been cleaned. It is always clean water.

Mr GILCHRIST asked how they regulated the quantity of air along with the water, seeing they had not separate pumps.

Mr STEWART said there was a screw at the cocks by which they could let in no air at all, or half air and half water.

Mr HASTIE said Mr Stewart might say if it was a long wall working and what percentage of refuse there was.

Mr GILCHRIST asked as to the size of the scree over which the dross passed, and if they had any experience as to whether the machine would wash the dross better if it were separated into the different sizes before washing, or if they preferred putting it through the screes.

Mr WALDIE said they had been in the habit of screeing the

stuff before washing it, but only as a matter of convenience. If in a hurry with an order they screed the coal at the pits before washing it. They did not find that it made much difference in the washing. There was a less proportion of dirt.

Mr GRANT asked if they found they could wash the very finest of dross with the same facility as the nuts.

Mr WALDIE said they had washed gum through a half-inch scree and stuff to the sizes of "chirls."

Mr GILCHRIST—Do you know the size of the screes?

Mr WALDIE said they were an inch and a half. When he spoke of "chirls" he meant something that went over and not through that.

The PRESIDENT, in adjourning the discussion, impressed on the other members Mr Waldie's recommendation as to further contributions on the subject. He had been very kind in bringing this matter before them, and he hoped other members who had washing machines at work would give all the assistance they could on the subject. In the meantime he moved a cordial vote of thanks to the readers of the papers which was heartily given.

THE INSTITUTE AND THE GLASGOW EXHIBITION.

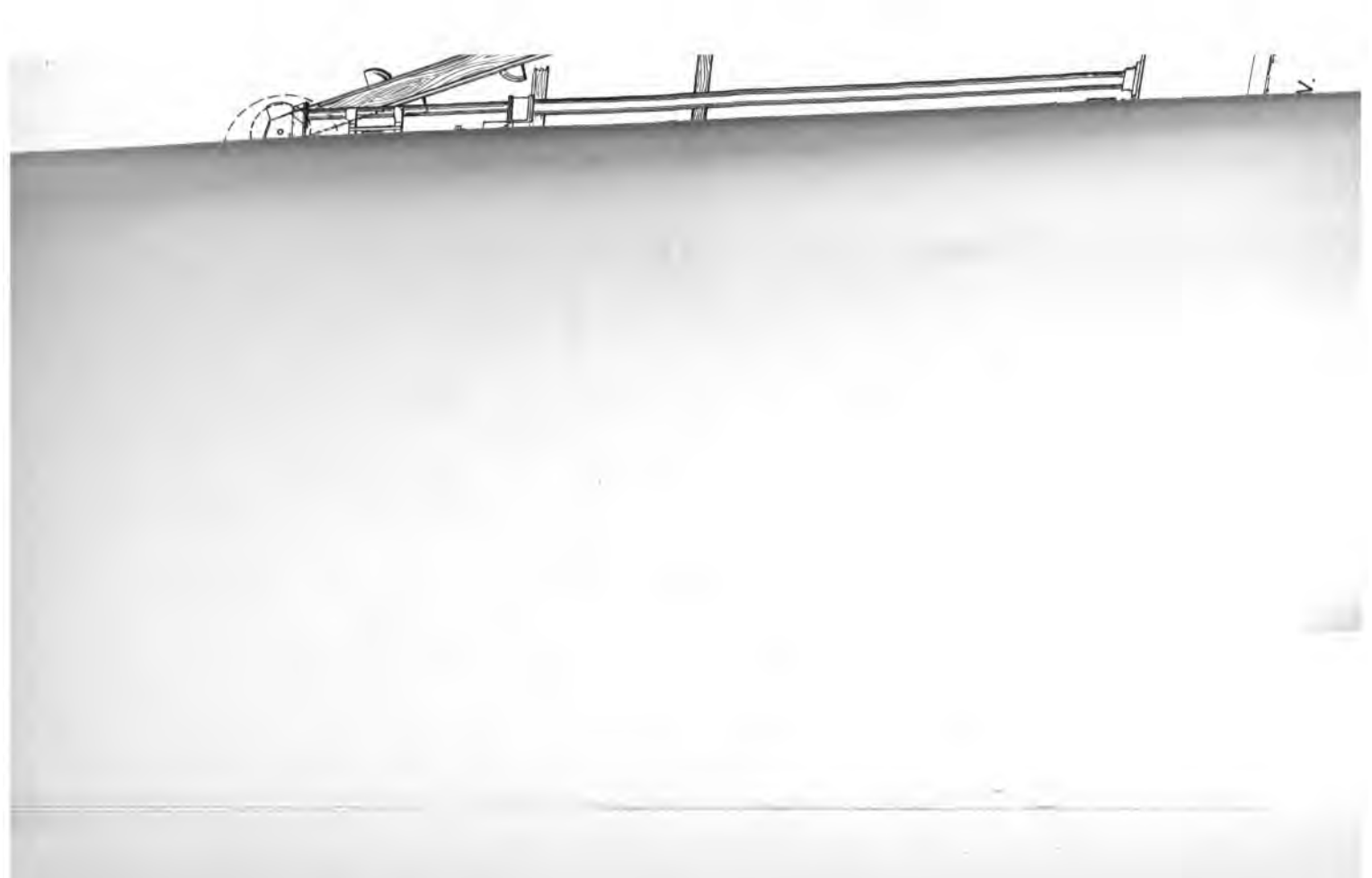
THE PRESIDENT called on the Secretary to submit a recommendation by the Council that an Exhibit of Sections of Minerals from the Scotch Mineral Fields be made at the forthcoming International Exhibition at Glasgow under the auspices of the Institute.

The SECRETARY said the Mineral Committee of the Glasgow Exhibition, of which Mr Dixon and other members of the Institute and himself were members, had suggested that there should be an

Exhibition of Sections of Minerals from the Scotch Mineral Fields similar to what there was at their own Mining Exhibition two years ago. The difficulty in asking individual coalmasters was, that under the rules of the Exhibition they would require to pay for space, and some of them thought that, if a charge for space were made, coalmasters would not be disposed to exhibit. But there was a provision in the rules by which institutions could have space for exhibits free, and it was thought that the difficulty might be got over if the Institute took the matter in hand and made the exhibit under their auspices. They would then make application for space and ask coalmasters to forward specimens. The object of the exhibit was educational, and in this way the cost of space would be saved, and it was probable that the proposal coming from the Institute, the coalmasters, especially those who were members, might be disposed to go into the matter heartily, so that there might be even a more complete exhibit than that at their own Exhibition in Glasgow.

The PRESIDENT said that he and the Secretary along with the manager of the Exhibition visited the ground some weeks ago, and had pointed out a very suitable piece of ground for the purpose of the proposed Exhibit near the machinery courts. It was a very likely place for people taking an interest in machinery seeing it. They sent in a plan of the ground necessary which was now before the Executive Committee of the Exhibition. He thought it very desirable that the Mining Institute should take the matter in hand. It had been further proposed that there should be a haulage exhibit, but they did not see their way to recommend it, because the grounds were limited, and the public were not much interested in such technical subjects. He hoped the coalmasters would second their efforts by sending in good sections of their minerals.

The Council's recommendation was unanimously agreed to.



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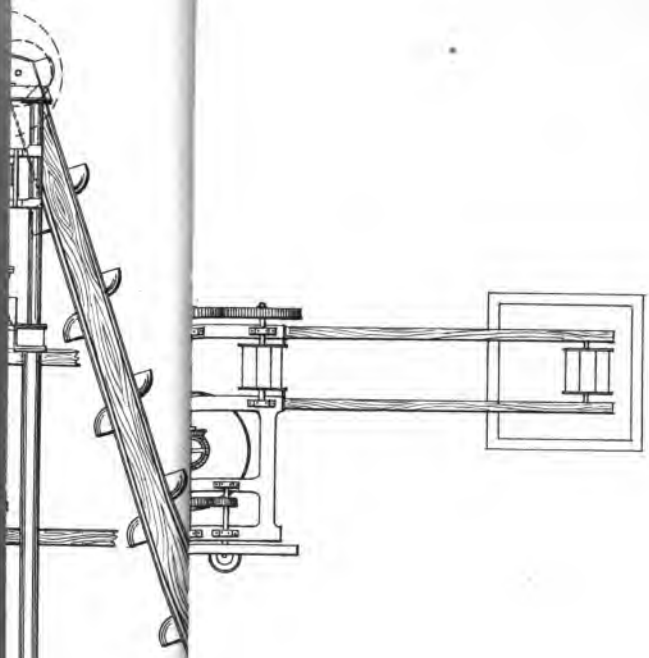


V.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD IN THE

ROOMS OF THE CHRISTIAN INSTITUTE, GLASGOW,

22nd December, 1887.

JAMES S. DIXON, Esq., President, in the Chair.

About 25 members were present.

The minutes of the former meeting were read by the Secretary and confirmed.

WILLIAM IRVINE, Auchenstary, Kilsyth.

was elected by ballot as an ordinary member.

The following discussions then took place :—

DISCUSSION OF MR BEST'S PAPER ON "ACKROYD & BEST'S LAMP CLEANING MACHINE."

Mr DAVID FERGUSON said—One of Messrs Ackroyd & Best's lamp cleaning machines has been in operation at Cadzow Colliery since 14th October last, and Mr Barrowman, who has been to the colliery and witnessed the machine at work, has requested Mr Austine to furnish the Institute with a statement of the results obtained from it, which on his behalf I now do. We shall first give a short account of the work done in the lamp cabin previous to the introduction of the machine, and, taking the cost of six months' work, reduce it to the cost for 59 days at the same proportion, that being the time the machine has worked, so that the results in each case can be compared. The lamps used while hand labour cleaned them was as follows:—Davy Lamps, 100; Williamson, 280; Scotch Gauzes, 190. Only the Davy and Williamson lamps were cleaned in the cabin, the Scotch gauzes being cleaned by the men who worked with them. The labour charges were:—

3 Boys, cleaning gauzes and scouring brass and glasses, - - - - - -	at 1s 3d,	3s 9d per day.
1 Boy, unscrewing and screwing up, -	at 1s 3d,	1s 3d „
1 Man, oiling and putting in wicks, -	at 3s 0d,	3s 0d „

The cost of brushes and gauzes was as follows—

		£	s	d
Williamson gauzes, - - - - - -	18 at 9d,	£0	13	6
Davy gauzes, - - - - - - -	23 at 6d,	0	11	6
*Repairs generally to Scotch gauzes, - -		5	10	0

* The Scotch gauze repairs are left out in the total.

Brushes, - - - - - - - -	2 at 1s 8d,	0	3	4
Brushes, - - - - - - - -	14 at 8d,	0	9	4

The total sums expended during 59 days' hand labour were—

	£	s	d
Labour (cleaning and oiling), - - - - - -	£23	12	0
New Gauzes, - - - - - - - - -	1	5	0
New Brushes, - - - - - - - - -	0	12	8
Total, - - - - - - - -	£25	9	8

The Scotch gauze lamps were discontinued about the time the machine was got, and the Marsaut lamps substituted for them and cleaned in the cabin, and with the machine at work the following are the results:—

Lamps cleaned—			
Davy lamps,			100
Williamson lamps,			280
Marsaut lamps,			190
Total,			570
The labour was—			
4 Boys, working at the machine and screwing, etc., at 1s 3d,	£0	5	0
1 Man, oiling and putting in wick, at 3s 0d,	0	3	0
Total,	£0	8	0
The brushes and gauzes used were—			
Brushes, 9 at 0s 8d,	£0	6	0
Do., 1 at 2s 0d,	0	2	0
Do., 1 at 12s, one-third worn,	0	4	0
Total,	£0	12	0
Williamson gauzes, 21 at 0s 9d,	£0	15	9
Davy do., 6 at 0s 6d,	0	3	0
Marsaut do., 2 at 1s 0d,	0	2	0
Total,	£1	0	9
The total sums expended were—			
Labour (cleaning and oiling),	£23	12	0
New gauzes,	1	0	9
Brushes,	0	12	0
Stores to engine,	0	4	0
Total,	£25	8	9

The figures for hand cleaning and by the machine are practically the same, but the machine cleans 190 more lamps, and does it far more efficiently. These figures do not include oil, wick, and general repair, which are not taken notice of in this statement, neither are the wages of the man in charge of the lamp room. Some people think that the gauzes are worn prematurely by the action of the machine, but Mr Austine is of opinion that we have not had sufficient experience to come to a conclusion on that point.

The PRESIDENT said he had been at Cadzow and seen the machine at work, and it seemed to do what was required of it very efficiently. He thought any one with a large number of lamps to clean might do well to think of such a machine.

Mr FERGUSON explained that at Cadzow, owing to the breaking of glasses incident to the handling by the boys, they had stopped the unscrewing by means of the machine.

The PRESIDENT—Then it is used by you only for brushing and polishing?

Mr FERGUSON—That is so.

On the motion of the President, a vote of thanks was tendered to the patentees for bringing the machine before the Institute, and to Mr Austine and Mr Ferguson for the information furnished by them.

DISCUSSION OF MESSRS M'PHERSON'S PROPOSED SCHEMES FOR KEEPING MINES CLEAR OF INFLAMMABLE GAS.

THE SECRETARY said, as bearing on the first of the two schemes in the Messrs M'Pherson's paper, it was interesting to notice the note, page 36 at the end of Part V. of the Transactions, on Sir Frederick Abel's paper on "Accidents in Mines," read before the Institute of Civil Engineers, in which it was stated:—"The state of high tension in which gas occurs in some coals is frequently the occasion of accident through the bursting of the coal from the working face, or the discharge of volumes of gas with which no ventilation can cope." He did not know if they could point to such extreme cases as this in Scotland, but he had no doubt there were cases in which there were very large discharges of gas, with which, he was afraid, the Messrs M'Pherson's little tube would not have much effect. A member remarked to him in conversation a few days ago that boring a hole in the coal face might serve for the solid, but what about the stoop side? Was a little $\frac{1}{8}$-inch tube in the corner to carry away the gas from the stoop side?

Mr M'PHERSON described the following experiments which he

had lately made in drawing off gas from the coal. These experiments were tried in the Splint coal, Trabboch Colliery, with an air pump specially made for the purpose. The pump was 2⅜ins. diameter and 4½ins. stroke. To it was attached a vacuum gauge to shew amount of depression. The first experiment was tried in No. 2 Pit, in a place working to the rise, 9½ft. wide and 5½ft. high. The total height of coal is 7ft. 4ins., but head coal was being left on here. The coal is divided near the middle by a parting, and the hole was drilled in the upper part of the seam. After the pipe had been inserted into the hole, which was 2ft. 9ins. deep and 2ins. diameter, and tamped up, the pump was started, and in 73 minutes a bag of 5 cubic feet capacity was filled. The pump was kept at as near as possible a uniform speed of about 70 strokes per minute, and the depression produced in the hole was about 10lbs. per square inch. The hole was drilled at least three hours before the experiment commenced. In the second experiment the hole was drilled in the side about 12ft. from the face, 3ft. 6ins. deep and 2ins. diameter, and the position was about 12ins. above the parting. The pump was kept going about the same rate as in the previous experiment, and the depression produced was from 5 to 8lbs. per square inch. In this instance the bag of 5 cubic feet was filled in 18 minutes. In the third experiment a hole was drilled in a stoop which had been exposed for over five months; depth of hole, 2ft. 9ins. In this instance there was no means at hand of collecting the gas, as the bag was full; but when the pump was started the gas was given off freely and burned at the end of the tube, with a flame about 8ins. long. Mr M'Pherson, continuing, said these are all the experiments that have been made, but others are in progress; but so far as they have gone they are very satisfactory, as Trabboch is not a fiery colliery, open lights being used, yet the gas was got freely in every instance. The gas, so far as rough tests went to shew without analysing, was pure, or nearly so; and there seems no reason to doubt that if sucking arrangements were placed in every working place, the volume of gas that could be got would be large enough to be financially valuable, apart altogether from the question of safety. The coal in which the system of stooping described was tried was the

Hurlford Main coal, which corresponds with the Lanarkshire Splint. The following is a section for a short distance above the coal:—

	Feet.	Inches.
Soft light blaes,	18	0
Gas coal (coarse),	0	10
Dark parroty blaes,	0	8
Dark grey fakes and fireclay,	1	10
Sandstone plies,	2	7
Dark grey fakes,	2	8
Do. and sandstone plies,	2	3
Dark fakes,	12	0
COAL (Hurlford Main),	4	6
Fireclay,	0	2
Strong light fakes,	6	0

Mr M'Pherson then read a translation of an article which recently appeared in a German technical journal bearing on the subject. The translation was as follows:—

THE SUCKING OUT OF MINING GASES, AND THE USE OF THE SAME FOR HEATING A BOILER.

At the meeting of the Natural Philosophy Society at Aachen, on 9th May, 1887, Herr General Director Hilt made the following communication:—

I take the liberty of laying before you two matters which in themselves are of much importance. For proper treatment they would require to be dealt with at greater length, but since they are mining matters that are in question, and the more precise details of these have no interest with the greater number of those present, I consider it best to lay before you in the form of technical communications only the most generally interesting aspects.

The first of these communications is concerned with fire-damp. You are aware that up to the present time we are acquainted with no means of actually removing the gas; hitherto, our efforts have been confined to diluting the gas, so as to render it harmless. It is true that for a long time the idea has been pursued of getting rid of the fire-damp in some way or another, and various ways and means have been proposed; but hitherto these have shewn themselves to be wholly impracticable. The only way to

attain the object is to get hold of the fire-damp and remove it from the mines before it is mixed in large quantity with the atmospheric air, as has ere now been done to a certain extent with blower gases. Various proposals were laid before the Prussian Firedamp Commission, all of which were shewn by it to be unrealisable in practice.

During the labours of the Commission on Firedamp, I considered the matter more closely, having the more reason to do so, as in 1872, I had deeply studied the same idea. In the mine of Kampchen, I had made an experiment, which, for reasons which I need not further mention, proved a failure.

The works of the Prussian Firedamp Commission opened up new points of view, by the proper consideration of which I believed I could attain a better result.

The first is the exact determination of the time which is necessary for the diffusion of the mining gas. At Neunkirchen it was shewn that, if a certain quantity of mining gas was introduced into the experimental gallery on the floor, this quantity was found again at the roof, and that it remained there a certain time, and only gradually mixed with the atmospheric air.

If 1 cub. metre of mine gas was introduced into the chamber of 10 cub. metres content, almost the whole of this gas was found, after the lapse of an hour, in the neighbourhood of the roof, and only completely mixed with the air after an interval of from three to four hours.

Naturally the case is otherwise when we have to do with air in motion. Before the faces of the galleries and in the case of pillar workings, the speed of the current is for the most part very small, so that we might reasonably expect that here also the greatest part of the mine gas would be found only a little mixed with atmospheric air.

The second observation was made at the mine Westphalia by Director Hilt. By means of an experimental mine, which was controlled with great care, he has shewn that the firedamp which is developed comes almost entirely out of the fresh face, and in such a way that the greater quantity streams out during the first hours, and after a few days the escape of gas comes altogether to an end, so that in the front of the face of the galleries that are

being wrought by far the greatest part of the mine gas is to be found, the backlying faces giving out almost nothing more of carburetted hydrogen gas, and blowers not making an appearance.

These observations have been confirmed by those made during the months Sept. to Nov., 1885, in our mines (Coulay & Gemeinochaft) to determine the influence of the changing air pressure on the quantity of mine gas escaping. These shewed that even the change in the course of working during the day could be recognised in the amounts of gas in the different portions of the pit. Under circumstances otherwise alike, the current at the close of the morning shift contained the largest quantity of fire-damp, because the output of coal was especially large during this shift, and at the close of the night shift it contained the least, because during this shift the output of coal is almost at a standstill.

On the basis of these facts I founded a plan for getting hold of the mine gases in the mine by leading a system of iron pipes from the surface throughout the mine, and providing them at the faces with sucking apparatus which suck up the gas at the roof continually. By means of a powerful air-pump on the surface, sufficiently-strong rarefaction of the air is produced throughout the entire system of pipes.

The plan for this arrangement was completed three years ago, but the cost of carrying it out appeared too great, and it had therefore, to be given over until, owing to certain circumstances, a specially favourable opportunity for its accomplishment offered itself at Konegsgrube, where air pressure machinery being out of use could be employed for my purpose. Not only machinery was available, but also the main communication with the mine, and it was only necessary to change the air pressure machine into an air-pump, and besides, from the existing system of pipes, to set up the junctions and branch pipes to the most important working points of the Konegsgrube mine, and this was rendered easier by the fact that for some years the pit had been closed, and in consequence has to-day only a small number of working places. Two and a half months ago the experiments began, and the result is favourable beyond expectation.

Out of this section, which has an output of something like 100 tons per day, and in which somewhat fewer than 100 workmen are employed, it is possible to suck out ·6 to ·8 cubic metres of mine gas per minute, consisting of 92 to 94 per cent. of air, and 6 to 8 per cent. of gas, while the current in the mine contains now only ¼ per cent. of gas, and even less.

The gas mixture thus sucked up shews in the course of the day but few variations, and can always be recognised at the safety lamps as an explosive mixture, but to form an exact opinion of its composition, two samples are taken daily and carefully analysed. We can, therefore, say that the experiment is wholly successful.

The mine of which we are here speaking is in other respects ventilated in just the ordinary way. I am of the opinion that if the sucking up of the mining gas become common, we must in general pay no less attention to the ventilation than hitherto. To give an idea of the circumstances under which the sucking off of the mining gas, in the case here described, takes place, let me add further that the quantity of air introduced into the working amounts to 200 to 220 cubic metres, which, with an output of 90 to 100 tons, gives about 2·2 cubic metres per ton. It is generally considered that 1 to 1½ cubic metres per ton is sufficient, so that the introduction of air is a very large one. In the largest shift there are 55 to 60 men engaged, and so the quantity of air is found to be 3 to 4 cubic metres per man per minute, while we generally consider two cubic metres sufficient.

So we ventilate the mine as well as it can be done, and the fact must be specially emphasised that the division of this current over various working points is very carefully carried out. Throughout the entire work a system of bratticing is established which as is well known presents great advantages for the proper division of the current, and by means of which it becomes possible to bring the current to the front of the faces, and almost altogether neglect the ventilation by means of diffusion.

With such ventilation, it is quite unavoidable that a certain quantity of the gas escaping shall be at once seized by the current and carried off; and we must look upon it as highly satisfactory

that, notwithstanding this, a mixture with 6 to 8 per cent. gas, and therewith at least 60 per cent. of the entire quantity developed can be taken up with the aid of the suction system. It will of course be possible to secure better results in both directions when the arrangements in a working are carried out with mine galleries and pillar structures.

A compound containing a higher percentage than 10 per cent. will however be got only with difficulty if the ventilation is sufficient; but a higher percentage does not seem to be necessary, because in this mixture it can quite well be used as burning material, an object which must be striven after in order that the practice may present economic advantages, and so be adopted more quickly and more generally, At present with our machine we suck up per minute about 10 cubic metres, of atmospheric pressure, which, with a quantity of about 6 to 8 per cent. of mine gas, contains at least ·6 cubic metres of pure gas per minute. The machine can suck up three or four times this quantity, and so making connections with further portions of the working, and in the event of its being possible to increase the quantity of gas 8 to 10 per cent., we will soon be in a position to suck off 2·5 cubic metres of pure gas without having to lay down any new machinery, perhaps even about 3 cubic metres.

As already remarked, the whole thing has a prospect of being generally adopted, only if we can turn the gas to some use. Mine gas compound, in which 9 to 10 per cent. of carburetted hydrogen gas is present, contains as much oxygen as is necessary for combustion. It is only to be remembered that we have to do with an explosive material. Consequently where we allow it to stream out and to burn, we must adopt measures to render its return impossible.

According to the technical experiments of Professors Wüllner and Lehmann, in the technical high school of this place, in a pipe closed at one end with even a 10 per cent. mixture, the spreading of the flame from the open end was only quite slow and not far. In any case this is made certain, that the products of combustion accumulate, and that there results a mixture not capable of explosion. It will be otherwise if a slow stream issues from a wide pipe, and the danger will be still more increased if we introduce gaso-

meters in connection with the conducting pipes. We must, therefore, isolate the gasometers from the pipes by water valves, and besides where the gas issues from the pipes double wire gauze must be used, as we already actually do in blowing out the gas through the apparatus under the grating of the boilers, there to be consumed.

As is well known, the calorimetric effect of mine gas is about 13,000 (calories) against 8,000 in the case of coal, and we can, therefore, with a sufficiently large heating surface for the boiler turn 15 kilograms of water into steam for 1 kilogram of mine gas if we introduce the latter in a mixture of 8 to 10 per cent.

With a quantity of ·6 cubic metres per minute, we get, in twenty-four hours, 864 cubic metres, or about 550 kilograms, which can in round numbers convert 8000 kilograms of water into steam. If out of the entire quantity of the mines of the Union Company, amounting to 18 cubic metres per minute, we could get by means of suction 60 per cent., this gas would be able to convert into steam 160,000 kilograms of water daily.

This, however, is the worst way of using the gas, and we must try to discover some better use. Its use for the driving of gas power engines at once presents itself. In an 8 to 10 per cent. mixture we have in point of composition precisely what these require. Then there is this effect, very important in regard to its use as a motive power for small machines, that it is a gas entirely free from smell. In the 25,000 cubic metres of mining gas which our mines yield daily, even if therefrom we could suck up only about 16,000 cubic metres, we could probably provide almost the entire city of Aachen with the power required for the factories.

There is a further use. As is well known, hydrogen is used in specially constructed burners as an illuminant. The mining gas burns with a blue and very hot flame, and so the possibility is not precluded of using it also for lighting purposes if suitable burners are constructed. If lighting gas (coal) costs 15 pfennige (about 1·8d) per cubic metre, it will perhaps be possible in some way or other to sell mining gas at 10 pfennige (about 1·2d) per cubic metre, which would produce for the Union Company on 16,000 cubic metres, 1600 marks per day, or more than 500,000 marks (£25,000) per year.

But even if the sale must take place at actually lower prices, we can see at once that even in financial respects, the matter is of very great importance, and that the mine gas, instead of being the dangerous enemy of the miner, can become the source of new prosperity to the coal mining industry.

Mr FERGUSON asked Mr M'Pherson to give the length of the main piping that would be required. He stated that he did so because in one seam of Cadzow Colliery 5000 yards would be required, which would entail a first expenditure of £500 for pipes alone, and this did not include branch pipes to the faces, but main pipes only.

Mr M'PHERSON said if they were to make £25,000 a year that would not count much.

Mr F. J. ROWAN said, in order to make money out of the gas it would be necessary to have in the neighbourhood of the mines either large consumers or a town as in the case quoted. The report of the German experiments had, however, touched upon the real danger connected with the scheme, and that was the admixture of air with the gas, which was inseparable from the very method of collecting it. This struck him on first reading Mr M'Pherson's paper, and the experiments of Mr Hall which were quoted by the Royal Commission on Mines occurred to him as showing this danger. He found on reading further that Mr M'Pherson quoted these experiments for another purpose. At p. 143 of their Proceedings this quotation occurs:—"In one experiment in the Bastian seam, a slight diminution of pressure was thus produced, but almost instantly the pressure due to the gas, or to air which had been drawn into the coal and become highly charged with gas, was sufficient to balance the atmospheric pressure." It was there found that the mass of coal was sufficiently porous to allow air to be drawn in as well as the gas, and thus the possible danger would be the collecting of an explosive mixture. For that reason, it was very important that the gas which had been collected by Mr M'Pherson should be analysed, because, in the event of an explosive mixture being collected, it would be extremely difficult to isolate the gas-holder from the pipes and apparatus for conveying and using the gas. Therefore,

if at any time the velocity of exit of the mixture—the gas and air—became less than the velocity of ignition, the flame would flash back and explode the gas-holder. That was a practical difficulty in the way. If they were merely piercing through the coal into crevices where gas was accumulated, it would be a simple matter to provide for drawing off the gas, but that did not seem to be the problem before them. Even then, however, in the case of reaching any great accumulation of gas such as Mr Barrowman had already mentioned, small pipes would be utterly incapable of coping with any blower such as some of those mentioned by the Royal Commissioners, or some of those known in coal mines in England. He heard a little while ago (but did not remember it until that evening) from Mr Ward, that about a year ago an English engineer of, he thought, the name of Hill, had taken a patent for a scheme for the same purpose as Mr M'Pherson's,—for withdrawing the fire-damp and utilizing it at the surface in gas engines for producing electricity for mining purposes and in other ways.

The PRESIDENT said the workings of a mine were practically a pipe through which air was made to course to carry off the gas, and if it was properly carried off he thought it the most practical way of getting rid of the gas. If that gas could be utilized then that was another question altogether, and a question, he thought, they might study and keep before them; but for the one purpose of eliminating the gas from the workings the present plan was, if properly done, about the best that could be adopted. Mr M'Pherson said the pipes would require to be withdrawn when the miners were at work.

Mr M'PHERSON—When taking down the coal.

The PRESIDENT—That is the time when the gas would be given off to a large extent and ventilation would require to be resorted to.

The SECRETARY—In this scheme the gas is isolated from the air in the workings.

The PRESIDENT—If diluted sufficiently it comes to the same thing. He invited discussion on the second part of the paper,—the leaving of an air-course round the goaf and the workings for the purpose of drawing the gas from the goaf. In Mr Dickinson's

recent address to the Manchester Geological Society, of which he was President, he referred to this method to the effect that outlets for gas on the rise side of goaves are systematically practised in some districts, and when not provided the difficulty and danger of dealing with firedamp is found to be greatly augmented. Some members might have a knowledge of those districts where this was practised. He had not come across it himself. On the Continent, where the mines were steep, this process of ascensional ventilation was the common system. He did not know whether Mr Dickinson referred to that or not.

Mr DUNDAS SIMPSON said Mr M'Pherson would perhaps be kind enough to let them understand what was the dip and rise of the workings, and if those stoops that were taken out were to the rise or the dip.

Mr M'PHERSON said they would observe that the paper was read on behalf of his father and himself, and the experience was that of his father. The section was being worked totally to the rise of the pit, and it was a few years now since it was done. The dip and rise was 1 in 7.

The PRESIDENT said he would like to know if the area of the waste did not get so fast that the air could not penetrate it.

Mr M'PHERSON—That was not the case in the example given, but it would require in that case to be worked in panels.

Mr GILCHRIST said that he could bear out what Mr M'Pherson had said as to the advantage of an air-course being kept round a stooped waste where that is possible. His attention was first drawn to this when he found it necessary to cut a barrier of coal left between two sections of workings that were aired separately. No. 1 section was to the dip of No. 2, and the stoops nearly all removed, when the barrier between it and No. 2, where stooping was also going on, was cut through, it was first cut about the centre of No. 1 section, and gas passed freely through the opening, and at every place cut through the barrier higher up the gas drained off at that point. He might also mention that when there was a crush or creep on the waste, the quantity of gas passing was much increased. After the first opening was made, gas was never found where the workmen were removing the stoops. It was after seeing the waste of No. 1 section in a great

measure cleared of gas that he thought of trying an opening specially to drain the gas off No. 2 waste. The return air-course of No. 3 section was protected by a solid barrier of coal, so he cut through the barrier a place 10ft. wide at nearly the highest point, and all the gas in No. 2 section passed into No. 3 return air-course; at that point only a small quantity of air was allowed to pass through the opening. Gas was always given off at that point till the section was finished, when the air was cut off. It appeared to him that Mr M'Pherson's system could only be carried out by taking the dip workings first, and so arranging the air-courses that the gas given off in one section would not be passed on to another.

The PRESIDENT said he could conceive a working in which stoops were being taken out and coal being worked on the rise, and there was no doubt it would be successful in drawing off the gas. In his experience of large areas of stooping, the gas did not come through the body of the waste, but percolated down along the sides. That was to say, the strata was left hanging along the edge, and those were the points they required to watch. He agreed with Mr Barrowman and Mr Gilchrist that, in the Hamilton district, they would require to leave a large amount of coal to stand the pressure, and this coal would never be got out.

Mr HASTIE said, suppose they were to take a large field and leave 30 or 40 yards to protect the air-course, and a neighbouring colliery owner worked up to it, the air-course on that side would be lost. He thought if they did leave so much coal, they would have the landed proprietors coming on the lessees for loss of coal.

Mr DUNDAS SIMPSON said that, from the nature of the strata Mr M'Pherson had just mentioned, he rather feared the goaf would close up very quickly; and, if so, to force the air under such circumstances into the goaf the air would be jammed from going round the air-course as well, and they knew what this meant. Since Mr M'Pherson read the paper he had been trying experiments, but had not yet finished them. In one of their pits they had to leave a stoop to protect a property. While stooping they came upon a great amount of gas, and always got abundance of it to the rise, the air having

come from the level and taken the gas to the rise workings. The place had been abandoned, and he was trying it to see if he could find any gas. He could get plenty down in the level but none to the rise. He had been putting air in to see what the effect would be. He had not found gas yet in the rise, but it might take some time for the air to keep playing on it to force it out.

The PRESIDENT said the trial Mr M'Pherson spoke of had a very material bearing on the question.

Mr M'PHERSON said in the instance he mentioned, where the ventilating fan was stopped to repair the shaft, the last place that gas was got was at the top of the holes. It gradually rose until it disappeared, shewing it was coming from the goaf.

Mr GILCHRIST asked if Mr M'Pherson did not think the air would be passing round the edge? He rather thought as he shewed it passing through the goaf there was a mistake. He remembered getting into an old goaf which was broken off the side of a bottom stoop. It had been standing waste for three or four years, sufficient time for it to fill up if ever it was to do so. He found he could get along the edge, and there was a considerable quantity of air passing. He considered the air passed along the edge of the stoop and up until it got into the return air-course,—not that the air passed through the goaf, because he thought it would fill up in such a way it would not be possible to pass air through it.

The PRESIDENT—Mr M'Pherson, of course, says it depends on the area of the waste, and I think he is correct.

Mr M'PHERSON—Yes; and here there was some of the strata above the coal that gave off gas very quickly after the break.

The PRESIDENT, in adjourning the discussion, expressed the opinion that if this new element of the gas products were developed there might be something in the scheme. In any case they were highly indebted to Mr M'Pherson for bringing the subject before them.

DISCUSSION OF MR JAMES F. WALDIE'S PAPER ON "THE STEWART-WALDIE AIR-AGITATED COAL-WASHER."

The PRESIDENT asked if the brass nozzles were, as stated, screwed in the holes from the inside of the pressure chamber, which was a very small aperture ?

Mr WALDIE said this was the case.

The PRESIDENT said there was one thing with regard to the quantity of dirt washed out. It seemed a particularly clean dross. To wash a dross with only 5 per cent. of dirt seemed to be almost superfluous. Mr Waldie mentioned 29·9 per cent. of dirt in one case. If it did that duty well, it showed that it was a machine fit for any dirty dross.

Mr WALDIE said he had explained how long the dross was in the washer and the area over which it passed whilst there. It had all that time for the dirt to settle, and the air had the effect of separating the dirt and the coal more quickly than the water alone. Mr Ferguson had been up at the pits and had made some experiments he (Mr Waldie) intended to make but had not had time.

Mr DAVID FERGUSON said he had seen Mr Stewart's patent washer at work several times, and had also been present at some of the experiments. The function of the machine is the suspension of the coal by a combination of water and air, under an artificial pressure, while the revolving horizontal paddle sends it out the delivery tube by centrifugal force.

He found, looking over the printed discussion, that the remarks made had been mainly directed to the merits of the air and water used in the washer, and keeping that in view, Mr Stewart had additional experiments made to test the relative values of water, and air and water in combination.

The first experiments were made with the pump getting as much air as it could take through the air valves, provided on the suction pipe, and the result was that while the agitation was very apparent on the surface of the water in the washer, it reduced the quantity of water coming from the pump, below the quantity sufficient to wash the coal and keep it in proper suspension.

The next experiments were made with clean water only, coming from the pump, and the air valves screwed up. The agitation on the surface of the water in the washer was scarcely evident, and at every stroke of the pump the pressure gauge rose with a jump from 45 to 100 lbs. per sq. inch, and the washing was very spasmodic and unsatisfactory, and the intermittent action of the water coming into the washer did not tend to clean the coal in a proper manner. The next experiment was made with the water and air mixed in the proportion which Mr Stewart finds to be the best for cleaning the coal, and easy on the machinery. This proportion is said to be half and half, water and air, but as the method of finding it is not rigidly accurate, it is only an approximation to the truth, but still sufficient for practical purposes.

With this proportion of water and air everything went smoothly and efficiently; the coal was buoyed up by the pressure beneath, and after revolving with the paddle, was finally ejected in fine condition. The pressure on the gauge was about 35 lbs., and it did not fluctuate more than 3 lbs. per square inch, showing that the pressure was steady.

To his mind the air mixed with the water is an essential element, and the requisite proportions of each, which is a matter of experiment, can be fixed by experience in working. The steadiness of the gauge is one condition of proper working. There cannot be any good work done where the pressure varies between 45 and 100 lbs. per square inch. There is too much surge to clean the coal and separate it from the dirt. When the washer is working with the gauge steady at 35 lbs. per square inch, the coal is well washed, and the dirt gets to the ball valve chamber at the earliest opportunity. In fact, if the dirt is allowed to accumulate until the dirt chamber is filled, the dirt clogging and circulating with the paddle without rising, acts like a brake on the engine, and whenever the ball valve is liberated, and the dirt lowered, the effect can at once be noted, the engine going off at an increased speed.

The distances between the holes in the perforated plate being only about $2\frac{7}{8}$in., the air issuing under pressure expands outward and upward, and keeps the whole surface of the water in the washer in agitation. With water only coming from the pump,

the probability is that it issues from the holes, more as jets, and partially agitates the water in the washer. The water is, practically speaking, non-expansive, while the air is very much so, and no doubt the efficient agitation is due to that principle of the air.

There is a table given in Mr Waldie's paper, showing the pressure required to force the agitation through various depths of water in the washing vessel. With the shallow depth, the law of pressure to depth of water is obscured, but taking the depths at 7, 9, and 11 inches respectively, and squaring them, we get 49, 81, and 121, and taking the pressure at seven inches equal to 17 lbs. per square inch as correct, the pressure at 9 and 11 inches should be 28 and 42 lbs., which does not differ much from 26 and 45 lbs. in the table. The law is evident. The pressure required for agitation is proportional to the square of the depth of water in the washing vessel, so that with a two-fold depth, we should require a four-fold pressure per square inch.

Mr GILCHRIST said he did not see it noted anywhere the quantity this machine would wash per day of ten hours. He gave the price of a 200 ton washer, but did this machine wash 200 tons per day, and what percentage of dirt was taken away by the water? Was the dirt that was dropped through the valve included in what was washed? His own experience was that a considerable quantity of fine gum or fine sand was washed into the filters and it was not lifted for nothing. In fact, it was the greatest nuisance of the whole thing, and the difficulty was to get rid of it.

The PRESIDENT said, as he understood, Mr Waldie had old boilers set on end in front of the boiler fires in which he caught that material.

Mr WALDIE said there were five boilers, and the whole of this stuff flowed into them. The maximum quantity washed was about 220 tons in ten hours. It had done 200 tons over and over again.

Mr GILCHRIST said it was a very important point that this machine was able to wash 200 tons while only 5ft. in diameter. Robinson's was 8ft. diameter for 200 tons. The quantity of dross in the machine must be very little compared with the Robinson machine which should be an advantage so far as driving is

concerned; but there could not be much time for it to settle. He was astonished at the rapidity with which it washed out, seeing there was so little surface.

Mr GILCHRIST asked if there was not a machine with air alone?

The SECRETARY said he believed it had been done with air on the continent.

Mr T. W. STAFFORD read the following remarks on the paper, which had been handed to him by a member :—

On page 147, line 26, it is stated that the water is forced through $\frac{1}{16}$in. dia. holes. Line 18 states there are 320 holes. Hence the area of one hole is ·00306786 of an inch or ·98 of an inch for the total openings. Thus the area is a little under one inch.

On page 151, the first line states there are 36 tons of water per hour, or equal to 134 galls. per minute. It is a question if they can get this quantity through the small hole.

Page 150 (third line from bottom of page) states there is a pressure of from 40 to 35 lbs. to the square inch in the water. This, say at an average of 37½ lbs. represents a column of water of 84 feet; washer only requires a column of 24 feet, or 71 per cent. less height, consequently less pumping power.

Page 151—One ton of gum at 2s is put down for boilers per day. 36 tons of water for ten hours gives a total of 360 to be lifted 84 feet. It will take 3 tons of good coal to do this.

In making up cost of washing, there is nothing entered for cleaning filters and tanks out. In washing 200 tons of fine dross, 25 tons of gum would be carried with the water into the filtering tanks, and will take 2d per ton to get out or ¼d on coal washed.

Page 148 (seventh line) states on pumps are fitted brass cocks. Air and water pumped into the pressure chamber.

Page 150 (last line) it states "half air and half water."

Page 151, it is stated 36 tons per hour, or 134 gallons per minute, or 21½ cubic feet of water. Consequently, there is an open space for air equal to 21½ cubic feet. This air entering at atmosphere pressure of 14·7 lbs., and compressed into a pressure of 37½ lbs., the 21½ cubic feet is reduced into 8½ cubic feet, equal

to a loss of 60 per cent. Does the dirt not set fast above the ball outlet? Also, when the ball is lifted does it not lift the dirt also?

Mr WALDIE said, as Mr Stafford's questions seemed to involve calculation, he would hold them over for answer until next meeting.

Mr ROWAN asked if air had been tried in any other form of washer. He confessed he did not understand the action of the air apart from this special form of machine. The ordinary action in washing coal was simply a question of the different specific gravities of the materials of the coal and other substances mixed with it, or their rate of sinking in water relatively to the speed of the water either when still or ascending or descending. It was quite easy to get a large volume of water to ascend at a given speed, gently, without shock, if it was forced up through numerous small openings like a sieve, as he believed was done in many forms of washers. In this machine, in the light of these restricted channels, he would say it would be difficult to get a large volume of water to flow readily, and the air might impart an artificial velocity to the water. Otherwise he could not understand of what use the air could be in mere washing of the coal. He had had in review information as to nearly all the washers that were known in connection with the preparation of a work on "Fuel," and he thought the members would derive some information from a series of papers published in *Engineering* in 1880, which went fully into the whole question, giving the law of descent of pieces of different size in water, which regulated the details of the various machines used for different materials.

The discussion was adjourned.

PROPOSED FEDERATION OF MINING INSTITUTES.

Copies of a Paper by Mr Bunning, read at a meeting of the North of England Institute, having been circulated,

The SECRETARY explained that the writer proposed, in the first place, to have a federation of all the Mining Institutes in

the country with headquarters in London. It was proposed that the subscription of members of existing Institutes to the Central Association should be 3, 2, or 1 guinea, according to the different grades, and this would include his subscription to the local Institute. The Transactions of the several Institutes were to be sent to the Central Institute to be published conjointly. The advantages were stated to be two—First, a representation of the mining interests in the quarter "where these could best be promoted." He supposed that meant that the Federated Institutes would be more powerful jointly than separately in matters Parliamentary. The second advantage was that the publication of those papers by the Central Institute would save the publication of the same paper by different Institutes as occurred at present. The matter had been before the Council at the request of Mr Bunning, and the Council did not feel disposed to give a deliverance on the subject. It was felt that it was better that the matter should be submitted to the Institute as a whole and deliberated on. A committee of representatives of the different Institutes was being formed, and it was desired that this Institute should be represented on it. The first point to be discussed was whether such a Federation was desirable at all.

Mr STAFFORD said the Transactions were only to be published once or twice a year.

The SECRETARY said his own opinion was that centralisation could be carried too far. Looking to the aims and objects of their Institute, he did not know if it was for its interest to amalgamate for the purpose indicated in the first place by Mr Bunning. So long as the Mining Association of Great Britain existed, he did not think it was essential or desirable that they as an Institute should identify themselves with that sort of thing, which he supposed was substantially a trade organization. As to what Mr Bunning conceived to be a disadvantage, viz., the publishing of the same paper in different Transactions, he rather thought it was an advantage, because they found certain mining appliances suitable and good in one district that were not in another. He thought that was one of the merits of separate Institutes. He questioned very much if the proposed rates of subscription would be sufficient, and suggested as a means of overcoming the difficulty

that was felt in knowing what was being published in the separate Transactions, that the proceedings of all the Institutes should be issued of one uniform size. At the end of the year, such a number as had been subscribed for could be sent to a central agency and bound, indexed, and sold to subscribers at a certain sum per annum.

Mr ROWAN took the opposite side of the question from Mr Barrowman. He had great sympathy with the proposal by Mr Bunning from a general point of view, although there were certain details he did not see the good of, notably the formation of a Mining Institute of London in addition to the Imperial Institute. He was in favour of a scheme of centralization on the lines of the Society of Chemical Industry in which there were local branches in several parts of the country. The subscriptions of membership of the Society were paid to the general fund of the Society. The sectional expenses were paid from headquarters, and the papers read at all the sectional meetings were published in a common journal, which was circulated every month; papers thus appeared during the month following the date on which they were read.

In reply to Mr Ferguson, the SECRETARY said he supposed those who were members of more than one Institute would not require to subscribe more than once to the Central one.

The PRESIDENT said his personal feeling was with Mr Barrowman. He did not see how this Institute could maintain the useful position into which it had worked itself under the proposed Federation. His idea would be, in the meantime, if those English Institutes cared to amalgamate, let them do so, and afterwards, when the thing was a practical success, they might join. In the meantime they should preserve their autonomy. He supported the Secretary's plan as to the publication of Transactions of a uniform size. As to the headquarters being in London, he asked who would go to attend Council meetings there. They would never be represented there at all.

The matter was remitted to the Council to take into consideration, and to communicate to Mr Bunning their views on behalf of the Institute.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON,

26th January, 1888.

JAMES S. DIXON, Esq., President, in the Chair.

About 40 members were present.

The minutes of the last General Meeting were read by the Secretary and confirmed.

The following were elected by ballot as ordinary members:—

DAVID L. SMITH, Barr Colliery, Beith.
ADAM SPEIRS, Westmains Cottage, Bathgate.
JOHN M'CULLOCH, Jawcraig Colliery, Slamannan.
WM. BROWN, Largoward Colliery, St. Andrews.

The following discussions then took place:—

DISCUSSION OF MESSRS M'PHERSON'S PAPER ON "PROPOSED SCHEMES FOR KEEPING MINES CLEAR OF INFLAMMABLE GAS."

Mr F. J. ROWAN said that last evening he referred to a plan which he had heard of some time before for effecting the same object as that of the Messrs M'Pherson, and he had since received a copy of the blue book describing the patent. The inventor's name was Mr Arthur Shippey, an electrical engineer in London. His patent was taken out in 1884, so that he was evidently the first to propose a practical method of withdrawing the ordinary fire-damp for use above ground. His plan was simply to allow the gas to collect in excavated places in the roof of the mine at various points, from which it was to be conducted to the surface by pipes. He did not propose to employ any means for sucking it up or exhausting the pipes such as was proposed by the Messrs M'Pherson and carried out in the German experiments, but he trusted evidently to the specific gravity of the gas (it being lighter than air) to carry it to the surface. He (the speaker) received at the same time as a description of the patent, a copy of the *Scientific News* of January 6th of this year bearing on the experiments referred to by Mr M'Pherson, the same notice being abstracted. The subject was therefore attracting some attention in England, With regard to what he said at last meeting, he wished to correct his remarks to this extent that when he said it would be necessary to have in the neighbourhood of the coal mines some large consumer like a town or something equivalent in order to make money out of the gas; he was simply referring to the proposal of Mr Hilt—and he understood the Messrs M'Pherson also—to use the gas for generating steam principally, or for driving engines for colliery use. As soon as they used the power to generate electricity, of course it was apparent that they might transmit that to a considerable distance and have their customers to whom power was distributed, although they were not in the neighbourhood of a town, and still make money by the power that they extracted in this way from the coal. There was one other thing that occurred to him, viz., whether it would not be practicable to collect the gas

in advance of the workings in ordinary coal pits in order to increase the safety with which the coal might afterwards be mined. He believed that, in consequence of the porous character of the strata, the coal itself, it would be possible to collect the gas from a considerable area by mechanical means. Where it was collected near the face, the danger was (as he remarked at last meeting) that air would be sucked in through the coal and, mingling with the gas, would form an explosive mixture. If it were possible to have a bore a considerable length in, it might be practicable to drain the gas off in that way and make the subsequent work perhaps a little safer.

Mr DAVID DUNN said he noticed in the Transactions, Part VI., p. 144, a paragraph from which it appeared that Messrs M'Pherson assumed a state of matters that was not permissible, and if it did exist in any colliery it would be considered a violation of the provisions of the Mines Act. If they were in this position, they might have gas to draw off in sufficient quantities to make a good commercial undertaking, and, with a system of piping such as had been suggested in the paper and described by the last speaker, it might be a commercial success. It was entirely, so far as mining was concerned, a matter of cost; but, instead of having the piping and pumping suggested in the paper, why not extend the present system of having narrow mines in advance of the working faces? Such mines serve the double purpose of opening out the coal field and taking off the gas in advance of the faces. He was pretty sure the members of the Institute would be pretty much of opinion that if this gas was dealt with by an adequate system of ventilation it would be a difficult question to collect it as Messrs M'Pherson suggested, and a far more difficult matter to collect it by the pipes they proposed. Certainly the theory seemed about correct, but it would be a very different matter if they attempted to put it in practice, even in their limited areas in Scotland. As to the second part of the Messrs M'Pherson's plan, that also seemed right in theory, but the authors appeared to him to overlook the fact that it would be practically impossible to ventilate the goaf that was indicated in the paper. He would like to ask them what good their air-course,—and he would suppose them to have a good current,—

what good could this do to the centre of this area, in the high levels of the broken roof? It could do no good, and was therefore totally unnecessary. If the suggestion had been to have in this area three such air-courses from dip to rise, they might lessen the chances of explosion, but not by having the air-current going round it.

Mr ANDREW KESSON, in reference to Mr Rowan's remarks, asked how, after the gas was collected in the roof, it was to be extracted.

Mr ROWAN said there was a system of pipes the same as in Messrs M'Pherson's scheme.

The PRESIDENT said this inventor forgot the gas might have to go down hill before it went up.

Mr DUNN said it was stated that the Messrs M'Pherson's plan had been a success in one experiment. He thought it would have been more satisfactory if they had got more light thrown on the cost of it, and area in which it was tried. He doubted it would be a very costly thing, and might render the mine entirely unprofitable, and that was just what they did not want.

The PRESIDENT, in closing the discussion, said it seemed to him the question as put by the Messrs M'Pherson was more a commercial question than one of safety. As he said before, the present system of carrying off the gas was a very efficient one if it was properly carried out by sweeping it away by a sufficient amount of ventilation. If the gas could be made of commercial value, that was another question altogether. It seemed to him the proper way of trying that, would be to estimate the quantity of gas likely to be got. If the number of cubic feet of gas in, say a six-feet seam in a hundred acres were calculated they would have some data. He was rather dubious about it, but that would be a practical way of demonstrating the matter. As regards Messrs M'Pherson's proposal to withdraw the pipes when the men were taking down the coal, that was the very time the gas was coming off. The *modus operandi* was not properly devised so far as that was concerned. As he said before, if this could be made a commercial article and it paid to extract the gas, he had no doubt it would be done, but they must have data to go upon before they could go to the expense of it. As to the ques-

tion of gathering gas from holes in the roof and places of that sort, as Mr Dunn had remarked, it should not be allowed to be there. In all well-conducted collieries, there was no such thing. In the centre of the goaf, on the other hand, there might be gas collected. The difficulty was to get it out. Mr Plimsoll thought he had discovered a scheme, and in the *Nineteenth Century* he proposed to make excavations before the pillars were taken out and build them round, so as to have a gasometer in the centre, and lay pipes through the goaf and up the pit. Probably there was as much in that suggestion as in any of them, but it had never been carried out.

After a hearty vote of thanks to the Messrs M'Pherson, the discussion on their paper was closed.

ON THE GENERAL PRINCIPLES OF COAL WASHING.

By Mr Fred. J. Rowan.

In the course of the discussion on the machine described by Mr Waldie,[1] questions have been raised as to the principle of its action, and the writer on that account thinks that some more detailed reference to the general principles of coal washing machines than was made at last meeting will be useful.

Coal washing forms an increasingly important step in the preparation of the smaller varieties of coal for the market. For the manufacture of coke, where the coal is usually first reduced to powder, it is even more important.

Careful classification of the different kinds of small coal according to size receives great attention on the Continent of Europe, but is generally neglected in this country by the majority of

1. Transactions, Vol. ix., parts 6 and 7.

mine owners, as was the case in France until recently, according to M. Callon's remarks in his "Lectures on Mining."[2] Where it is practised, however, it is found to be of great advantage, because there is a certain size or condition of coal which is the most suitable for different processes or operations, and sizing therefore enables the coal to be applied more easily and in the most suitable condition. In some parts of the Continent a higher price has been obtained for coal thus classified according to a suitable size than was previously paid for the same coal in a mixed state, having an average of larger pieces than was necessary for the purpose of the consumer. The large coal was thus set free for other purposes more suited to it. Hand-picking is generally resorted to in this country, and shaking or revolving screens are sparingly used in general. There is no doubt, however, that much of the hand labour could be replaced by mechanical methods which classify the coal more completely, at the same time treating it more gently, so that a smaller proportion of small coal and a less cost for sorting and handling result.

Washing machines are themselves classifiers according to size, besides being purifiers of coal from pyrites, shale, and earthy matters in general. Their use, with that of the other mechanical appliances for handling and sizing the coal, is regulated simply by the question of cost.

Comparing the treatment of ores and coal as regards the quantity and value of the products, M. Callon remarks,[3] "In the case of metallic ores, we have to operate upon small quantities of valuable substances, which admit of our having recourse to delicate contrivances and frequent repetitions of the same process, notwithstanding the amount of capital required and the high cost of labour entailed by it. In the case of coal, on the contrary, we are dealing with enormous masses of a substance of comparatively little value, the profit upon which is reduced to a minimum by competition. We are consequently forced to employ special machines, as simple as possible, acting automatically, as far as practicable, and capable of treating considerable quantities. We

2. Delivered at the Ecole des Mines, Paris; translated by C. Le Neve Foster and W. Galloway. London, 1886.

3. "Lectures on Mining," p. 144.

must generally abandon all idea of treating coal by frequent repetitions of the same process, or, at all events, do so sparingly, so as not to burden it with too heavy costs. And, finally, in planning the whole arrangement and the means of transport, we must have recourse to the best mechanical contrivances, so as to carry out the operations both with simplicity and economy."

It is not by any means a simple matter to select the best machinery for the treatment of a particular coal, because of the many varieties in the nature of coal and in the minerals mixed or associated with it, the differences in the manner and degree in which the foreign matters are mixed with it, the manner in which the coal breaks up, and all circumstances tending to produce varieties in the yield of ash in the large and small coal. Variations in washing machines, moreover, are needed according to the different sizes which it may be desired to treat in them; and the question of the amount of loss by the formation of mud or sludge has an important bearing on the means of treatment that are employed. These are all matters which demand experience in the treatment of different varieties of coal in order to their being properly dealt with, so that the interests of neither coal-master nor consumer shall be neglected, and it may safely be said that no general rule of treatment can be laid down, and no one form or arrangement of machines can be prescribed as suitable for all cases.

The process of coal washing, whatever may be the special machine employed, depends upon simple but very interesting principles, namely, the conditions which accompany or regulate the fall of solid matter in deep or shallow water.

It has been found that particles of different substances fall in a fluid at different speeds according to their densities and volumes or sizes. M. Callon[4] takes the case of a fluid, of a given density, at rest, in which a particle, having a certain specific gravity and section at right angles to the line of fall, is falling with a given velocity, and shows that three forces act upon the particle. These are 1, gravity; 2, the thrust of the fluid; and 3, the resistance due to the viscosity of the fluid, which resistance is proportional

4. *Op. cit.*, p. 47.

to the surface of the body as well as to the square of the velocity. He examined the action algebraically and worked out the different effects due to shallow and deep fluids, arriving at the result that in a shallow fluid or, in other words, at the very beginning of the fall, before there has been time for the velocity to become great, the motion takes place solely according to density. Consequently, "those machines which utilise only the first instants of the fall, will have a high effect as concentrators."

When the depth is sufficient for a regular state of affairs to become established, all particles having a like volume and specific gravity will have an equivalent rate of fall.

P. Von Rittinger[5] investigated the subject many years ago by means of numerous experiments, and found that in water the limiting velocities of particles of different diameters and different densities (that is the velocities of descent in still water which they do not exceed, but which become uniform for each piece respectively, when space permits them to acquire those speeds) are quickly reached, small pieces of 1 millimetre diameter reaching it in under half a second, and large pieces of 16 millimetres diameter in less than one second.

The following table gives some of Rittinger's results which illustrate this point :—

Nature of the Substance.	Specific Gravity.	Transverse Dimensions.	Values of the Velocity in				
			¼ Sec.	½ Sec.	¾ Sec.	1 Sec.	2 Sec.
		Millim.	Metre.	Metre.	Metre.	Metre.	Metre.
Galena, - - -	7·5	16	0·903	1·444	1·630	1·650	1·650
Pyrites, - - -	5·0	16	0·825	1·174	1·287	1·293	1·293
Quartz, - - -	2·6	16	0·570	0·767	0·801	0·817	0·817
Galena, - - -	7·5	4	0·704	0·814	0·823	0·824	0·824
Pyrites, - - -	5·0	4	0.586	0·643	0·646	0·646	0·646
Quartz, - - -	2·6	4	0·383	0·409	0·409	0·409	0·409
Galena, - - -	7·5	1	0.409	0.413	0·414	0·414	0·414
Pyrites, - - -	5·0	1	0·321	0.323	0·323	0·323	0·323
Quartz, - - -	2·6	1	0·203	0·204	0·204	0·204	0·204

From many experiments with different minerals, and from cal-

5. Lehrbuch der aufbereitungskunde. Berlin, 1867.

culations, Rittinger deduced a general law for the velocity of any substance falling in still water. This he expressed by the formula[6] :—

Velocity in feet per second, $= 1{\cdot}28 \sqrt{D\,(d-1)}$, where

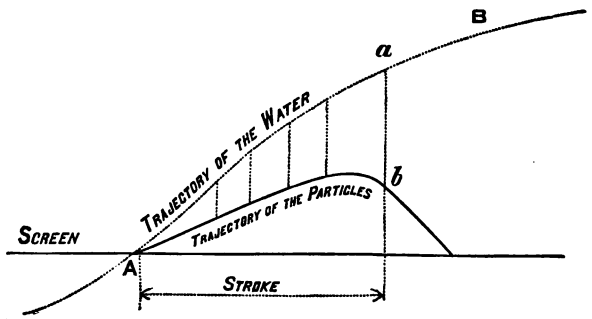
D = the diameter of inches of the holes in the riddle through which the substance has passed.

d = the density of the substance, or its specific gravity compared with water taken as a unity.

1·28 is a constant which was gradually arrived at from experimental results (where the velocity is expressed in metres per second, and D is taken in metres, this constant is 2·44.)

This general principle having been established for the case of substances falling through still water, it is found that it is applic able also to the varied conditions of an ascending regular current of water, a descending current, or a horizontal current.

If particles are subjected to the action of an ascending current, either the speed of the current may be equal to the limiting velocity of fall in still water—in which case the particles will remain stationary—or if the speed of the current be either greater or less than this, the particles will either rise or fall with a velocity due to the difference of speed. In a horizontal current, the particles will take a curved path, the shape of the curve depending upon the speed of the current and the density of the particles.



A very interesting diagram, showing in curves the trajectory of a particle of a mineral in relation to the trajectory of a particle of

6. Engineering, Vol. xxix. p. 4.

the water in a current was communicated by M. Marsaut in the discussion on Mr Harvey's paper on "Coal Washing" (in Min. Proc. Inst. C.E., Vol. lxx., session 1881-82—part iv.), and may be taken as affording a useful graphic representation of these principles.

The figure shows this diagram, regarding which M. Marsaut observed that "in effect, if the molecule of water and the particle first in contact left their trace on the drum of General Morin's well-known machine, the trajectory of the water would be a curve similar to AB, more or less approaching a sinusoid. The point A, where the screen had been shown, was that where the water had just the velocity limit of the particle in water and where consequently the water began to raise it. The particle rose in proportion to the velocity of the water, then stopped and retrograded as that velocity diminished. Hence it was evident that during the whole evolution the particle of coal had continuously descended with respect to the particle of water, developing ordinates comprised between the two curves, such as *ab*, representing the path traversed."

It is evident that air may be taken as the fluid, instead of water, and, allowing for the difference in density and viscosity, we may apply the same general principles to the separation of mineral substances by means of currents of air.

The use of air has been carried out in pneumatic classifiers in America and in the air-jig of M. Krom, mentioned by M. Callon; but it is evident that it is suitable only for materials in a fine state of division—such as sand or finely-ground ores—and that the currents of air must have a comparatively high velocity.

A mixture of air and water, as proposed by Mr Waldie, introduces a modified state of affairs not easy to follow unless the condition of the mixture and its average density were known.

If the water be broken up into a frothy state by the air, it is evident that the mixture will act as a fluid of less density than water but greater than air, and will not have the same effect upon large as upon small particles except at a higher speed of movement than water requires. If, however, the water remain sufficiently solid to allow the effect of its density to be felt by the mineral particles, then the air must act either in imparting a

greater speed to the water, or in producing irregular pulsations in the movement of the particles of the minerals, according as they are immersed in water or in bubbles of air. Comparative practice will no doubt determine whether these effects are advantageous or not.

Experiments have been made by Dr T. M. Brown[7] with a method of separating coal from its impurities by means of the employment of a fluid of greater specific gravity than coal but less than of slate, &c., associated with it. This fluid would have a greater density than water and would allow all coal to float while the impurities alone sank: and this result would be arrived at without motion of the fluid being necessary. A fluid sufficiently cheap and readily obtainable was found in the solution of calcium chloride in water and the results of experiments on a small scale were thoroughly satisfactory. These experiments illustrate effects of an opposite character to those produced by Mr Waldie's device, and they have a special interest for us on this account.

Before leaving this rapid sketch of general principles we may remark that Rittinger's fundamental law has shown the way to rules which should regulate the separation of coal by riddling, where this operation precedes the "sorting by equivalence" of the operation of washing. M. Callon[8] has given the theoretical expression of these rules, and the application of Rittinger's method, which we quote, is taken from the digest of M. Marsaut's paper,[9] published in *Engineering*. The determination of the limits of size within which preliminary riddling should be performed depends upon the density and consequent degree of impurity which may be taken as limiting the commercial value of the washed product.

The following table gives approximately the densities of pure coal and of the foreign substances associated with it, and the limiting velocities of pieces of different sizes as deduced from Rittinger's formula, $2{\cdot}44\sqrt{D\,(d-1)}$.

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7. Trans., Amer. Inst. Min. Eng., Philadelphia Meeting. Jour. Iron and Steel Inst., vol. ii., 1884, p. 700.

8. *Op. Cit.*, pp. 51, 52.

9. Bulletin de la Soc. de l'Indus. Minerale, 1879, Min. Proc. Inst., C.E., vol. lv., p. 259.

Materials in Pieces of Irregular Shapes.	Density.*		Limiting Velocity of Fall in Metres per Second.			
	d.	(*d* − 1.)				
Coal, pure, - -	1·3	0·3	0·267	0·231	0·189	0·134
,, shaly, - -	1·6	0·6	0·378	0·327	0·267	0·189
,, more shaly, -	1·9	0·9	0·463	0·400	0·327	0·231
Shale, pure, - -	2·2	1·2	0·535	0·463	0·378	0·267
,, with pyrites,	3·4	2·4	0·756	0·654	0·535	0·378
Pyrites, - - -	5·0	4·0	0·976	0·844	0·691	0·488
Diameter of Holes in Riddle. { Millimetres, -			40	30	20	10
{ Say, Inches, -			$1\frac{1}{2}$	$1\frac{1}{8}$	$\frac{3}{4}$	$\frac{3}{8}$

"When coal becomes so shaly that its density rises to 1·6, it can scarcely be considered any longer capable of being used as fuel. If this, therefore, be assumed as the limit of density or impurity to be allowed in the washed product, it is evident that before washing the stuff which has passed through a mesh of 40 mm. ($1\frac{1}{2}$in.), it should first be riddled again over a mesh of 20 mm. ($\frac{3}{4}$in.) to separate all below this latter size. For it is seen from the above table that the 20 mm. shaley coal of 1·6 density falls through the water with the same velocity (0·267) as the 40 mm. pure coal of 1·3 density; consequently the 20 mm. shaley coal, together with all smaller stuff of greater density, would fail to be separated from the 40 mm. pure coal by the washing." Similarly on this assumption with regard to density, any class of raw coal which had passed through one riddle should be riddled again over a sieve of half the previous mesh, thus:—

	mm.	mm.	mm.	mm.	mm.
From stuff which has already passed through a mesh of	40	30	20	10	5
Should be separated all that passes through a mesh of	20	15	10	5	$2\frac{1}{2}$

If, however, we wish to remove from the washed product merely the pure shale, having usually a density of 2·2, and all substances of greater density, a ratio of 4 to 1 for the preliminary riddlings would serve instead of the foregoing 2 to 1. Then

* The first column of density is the absolute density *d*, taking water = 1·0; the second is the excess (*d* − 1) above that of water.

	mm.	mm.	mm.	mm.	mm.
From stuff which has already passed through a mesh of	40	30	20	10	5
Should be separated all that passes through a mesh of	10	7½	5	2½	1¼

Other data may be assumed, but these examples will serve to show how the preliminary riddling may be arranged to secure a given result in the washed product.

"If a lot of *unriddled* small coal, such say as would pass through a mesh having holes of 40 millimetes (1½ inch) in diameter, were allowed to fall through a sufficient depth of water in any vessel, or were exposed long enough to the action of an ascending current of water, there would be formed in the vessel a series of horizontal layers, each composed of bits which had fallen through the water with the same velocity, and must necessarily be deposited at the same depth. Each thin layer thus deposited, with the exception only of the bottom one, would be made up of large bits of coal having the minimum density, of successively smaller pieces of less pure coal of greater density, and of shale and other impurities; the bits thus assorted being all of them equal in speed of falling or equivalent to one another throughout each individual layer." Several classes of stuff thus sorted in water by the simultaneous agency of size and density, present a different result from that produced by classification effected according to size alone by ordinary riddles; and it is evident that each class of stuff thus forming a layer could have the pure coal separated from the foreign matters in the layer by being riddled through a suitable mesh. The riddling is, however, usually done first, because it is found that the washing is more perfectly carried out when the coal is sized before washing, so that each size can be washed separately. This is easily understood from the foregoing principles and may be explained by considering the action of washing machines, as is done by Mr R. de Soldenhoff,[10] and by the fact that obviously a mixture of pieces of coal, shale, &c., of similar size can be more readily separated in water, than a mixture containing several sizes; there being a greater difference in velocity of descent for example, between a large piece of coal and a large piece of shale, than between the same piece of coal and a smaller piece of

10. Proc. S. Wales Inst. of Engineers. Vol. XIV., p. 88, &c.

shale. The apparatus employed in various places for classifying the coal according to size before washing consists of fixed screens, shaking screens (including the Briart patent screens), revolving screens, reciprocating tables, and pointed boxes or "spitz kästen," as they are called in Germany, where they were invented by Herr Rittinger.

The consideration of these appliances with a view to arriving at an estimate of their comparative value in the work of sizing would demand a separate study.

The different methods of washing which have been introduced, and in which the operation of the principles already mentioned may be witnessed, are extremely interesting, and demand separate and detailed description. We shall merely enumerate them in concluding these remarks.

The simplest and earliest form of washing apparatus is the open trough or sluice, which was no doubt borrowed from the practice in washing metalliferous ores. This form still survives in some places, and Rittinger's "spitzkästen" may be classed as a modification of the trough, although they are used for a primary classification by size. Then we have the various types of piston "jigging" machines, in which the water is either forced up through a perforated bed or sieve by the strokes of the piston, with an intermittent ascending current, or is made alternately to ascend and descend through the bed on which the coal is placed. There are also machines having a continuous ascending current of water, produced either by a column of water, with pulsations of a greater velocity given by a piston, or by a centrifugal pump.

Some machines having an alternate upward and downward movement of the water have a layer of felspar, or some suitable mineral, placed on the perforated plate or sieve, in order to develope the filtering action of the downward movement of the water. This improvement is due to Herr Lührig, who is acknowledged to be the leading authority in Germany on the subjects of coal and ore washing and classification.

In addition to these, there are the machines of M. Evrard and M. Marsaut, which, although governed by the same fundamental principles, yet exhibit original and ingenious methods of applying their action.

In Evrard's machine, the coal first falls through a depth of still water on to a perforated plate carried on the head of a hydraulic ram. The water is made to descend and ascend in a few irregular pulsations, and when it is at the highest point the sieve with the coal is caused to ascend slowly through it, when each layer of material is successively removed by being pushed or sliced off into waggons by a horizontal hydraulic ram. In Marsaut's machine, the coal is tipped into a large basket or cage, having a perforated bottom attached to the end of the piston rod of an overhead hydraulic cylinder. This basket is made to take successive regular drops of a few inches in still water, and is then withdrawn, the charge being removed in layers, the sides of the cage separating into horizontal sections, like drawers, to permit of this operation. These machines deal with a considerable quantity—four or five tons—of coal at a time, which makes up for their not having a continuous action.

All good installations of washing plant demand, as accessories, means for properly drying, and for elevating and conveying the coal both before and after washing. Complete installations manipulate the coal automatically from the moment of its arrival from the pit hutches until the different sorts are delivered into the proper waggons or receptacles. Means are also provided for removing and depositing the shale and other rubbish separated from the coal by washing.

DISCUSSION.

The PRESIDENT remarked that Mr Rowan had treated the subject from a scientific point of view, and had pointed out how coal-washing was effected. He had quite borne out his own ideas in regard to separating the pieces into sizes before washing. He had come to the conclusion that to make a good job, they should separate the coal into different tanks before washing the dross—say, from an inch and a quarter downwards as was frequently done. Certainly, it was a good thing to have these things corroborated by theoretical demonstrations, and he thought Mr Rowan had done that very plainly.

DISCUSSION OF MR WALDIE'S PAPER ON AN "AIR AGITATED COAL WASHER."

Mr WALDIE, in reply to criticisms by Mr Stafford at the former meeting, said—The first of Mr Stafford's questions points out that the area of all the openings from the pressure chamber to the washing vessel is only ·98 of an inch, and doubts if 36 tons of water per hour could be forced through this opening, but if the original paper at page 148 of transactions, line 11, be referred to it will be seen that the whole of the water is not forced through this area, but a considerable portion of it escapes through an overflow or pressure valve, shown at P. on plate V., the action of which is described also on page 149, line 3 from bottom of page.

Mr Stafford's second question refers to some other washer not named, and which I cannot, therefore, refer to, but would point out that if it is one depending for its water supply on a reservoir placed above the washing vessel, the height required for such a reservoir, and the pumping power necessary to fill it would probably in most cases represent more than a column of 24 feet of water, and under any circumstances, if extra pumping power is utilized to give a greater result in washing, it is no drawback to the machine which needs extra pumping power, and correspondingly less of something else.

The third question has reference to the quantity of coal or dross used. I have not been able to follow Mr Stafford's figures, no data being given, but would say that, in addition to the washer and washer pump, the same boilers supply one 20″, two 12″, and one 16″ engines, all going daily, besides a donkey pump for boiler feed, and the whole dross used averages 4 to 5 tons daily.

The fourth question, as to cleaning the filter ponds, is not one depending on this particular form of washer, but our experience is not that anything like 25 tons daily per 200 tons = 12½% of small stuff reaches the filter ponds, the great bulk of it being deposited in the settling tanks described on page 141 and 175 of Transactions. I have no separate note of cost of cleaning pond, but, so far as I can trace, it is about 8/ per 1000 tons (= ·09 of a penny per ton), and by arrangements now in progress we expect to reduce this to much less.

The fifth question refers to an apparent loss of 60% of (I understand) air in the pressure chamber, but, unless I am mistaken in the drift of the question, the reply to it is that the apparent loss referred to is fully recouped as the air leaves the brass nozzles, and expanding in the washing vessel into the area it originally occupied at normal atmospheric pressure assists, as described, in separating and agitating the mass of dirt and dross under treatment.

The last questions referring to dirt are replied to at line 5, page 151 of original paper, but I may repeat that the dirt never troubles us in any way by setting fast or otherwise. When the ball is lifted it lifts the dirt above it slightly, but not sufficient to lift it out of the top of the pocket shown at B on plate V.

He was very pleased to reply to these enquiries of Mr Stafford's. He thanked Mr Rowan for the very minute notes which he had gone to the trouble of putting together, and, when he got an opportunity of studying the figures in the Transactions, he hoped to get much information from them. As to the mixture of the air and water, he had not been able to work out the figures in the way Mr Rowan had done, but his own theory was that the air, as it left the pressure chamber, and expanding of course to its original atmospheric pressure occupied a much larger space in the washing vessel than it would do if it were not coming in in that way, and this perhaps assisted the coal to float to the top in something the same way as a fluid of greater density, such as Mr Rowan described as being experimented on in America. A member mentioned to him some time ago a simpler example by taking a tumblerful of ærated water and dropping into it a bit of coal, the air kept it floating while the foreign particles fell to the bottom.

Mr ROWAN said he should like, with reference to Mr Waldie's remarks, to ask him if he would be good enough to observe in those washing machines if the water was in a frothy state where the air mixed with it, because, if the air was expanding and going through those inlets with considerable velocity, of course it might act in buoying up the coal, and unfortunately do the same for all minerals it came in contact with, that fact being simply due to the velocity of the air. The air being of so much less density

than water, a particle of any size could not float unless by the force exerted at considerable speed by the air itself. The illustration Mr Waldie referred to of a particle of coal floating in a glass of ærated water, was not quite in point, because the gas was ascending with only the velocity due to its specific gravity in the tumbler. It was under no pressure. The pressure had been removed by the drawing of the cork. The gas bubbles were ascending simply with a speed due to the specific gravity which gave them time to adhere to the solid particles. He thought Mr Waldie would find that even a heavier substance than small pieces of coal would be held up on the same principle in a tumbler of ærated water.

Mr ROBERT STEWART said he had been much interested in the information Mr Rowan had so kindly laid before them, and, if time and opportunity permitted, and the discussion was left open, he should look up some facts he noted a year ago in connection with this matter. In the meantime, he might say, as regarded the formula given by Mr Rowan, and stated to have been made out as far back as 1866, he was pretty sure in a book he came across he saw a formula similar to this one, which, he thought, must have been a good deal older. It was in a book called "Leslie's Natural Philosophy," a very old work. Mr Rowan made one remark he did not quite think would be borne out by fact. He spoke of a small portion floating while another would sink. He rather thought they would both float if the specific gravity was the same.

Mr ROWAN said that all coal would float if all were equally pure, and if there was present a sufficient quantity of liquid to provide for the displacement of the larger pieces. The quantity of liquid would, however, be limited; the pieces of coal would not, if large, be so pure as the smaller pieces; and, moreover, the margin of difference between the specific gravity of the fluid and that of the coal and other materials was so small that a heavy mass of coal might turn the balance and down it would go. He did not suppose the plan had been tried except for small particles such as they had in ordinary washing machines.

The PRESIDENT said Mr Rowan had mentioned experiments by Dr. Brown. That was certainly the beau ideal of a coal washing

machine,—one in which the coal would float and other things would sink. Robinson's machines were somewhat on that principle. The head of water was supposed to be sufficient to float the coal and allow the other particles to sink to the bottom.

The discussion was continued.

FLAMELESS EXPLOSIVES.

The PRESIDENT reminded them that, since the new Mines Act came into operation, considerable restrictions had been placed on blasting in mines; and on his suggestion the Council was appointed a committee to report on the "flameless explosives" now in the market.

This was all the business.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD IN THE

ROOMS OF THE CHRISTIAN INSTITUTE, GLASGOW,

8th March, 1888.

JAMES S. DIXON, Esq., President, in the Chair.

About 30 members were present.

The minutes of the last General Meeting were read by the Secretary and confirmed.

The following were elected by ballot as ordinary members:—

WM. JEFFREY, Ladylands Colliery, Shotts.
SAMUEL ANDERSON, Barncluith Colliery, Hamilton.
JOHN TODD, Banknock Colliery, Kilsyth.

The Secretary, on behalf of the Council, submitted a list of the members of Council who were eligible for re-election as office-bearers for the ensuing session, and, thereafter, office-bearers were nominated in terms of sec. V., art. 3 of the rules.

The following discussions then took place :—

DISCUSSION OF MR WALDIE'S PAPER ON AN "AIR-AGITATED COAL WASHER," and MR ROWAN'S PAPER ON "THE GENERAL PRINCIPLES OF COAL-WASHING."

Mr GEO. A. MITCHELL said—We are very much indebted to Mr Rowan for his paper on the general principles of washing machines. We are too apt to go by rule of thumb in this as in other matters, and we often forget that we must know something of the scientific principles if we wish to know on what lines to proceed in improving our machines. Mr Rowan lays some of these principles very clearly before us, as for example the importance of separating the particles of coal into different sizes before washing. On page 193 he puts this very clearly. In *practice*, very fair results are obtained without separating, but undoubtedly the separation is an advantage practically as well as theoretically, and it may be worth while to consider certain conclusions which result from the principles laid down by Mr Rowan, specially in connection with this separation of the particles. Let us notice first that we can calculate from the formula given us—velocity = $2{\cdot}44\sqrt{D\,(d-1)}$—the number of pulsations per minute for any given machine that should be given for different sizes of coal. What I am going to say refers specially to the reciprocating double tank washing machines, such as those made by Barclay, Bell, &c. To get the best work for the machine, the pulsations should be such that the water is at the highest point in the tank and the stroke just turning when the last of the particles have just come to rest on the surface of the perforated plate. If there is quicker agitation than this, the particles are not allowed to fall by their own gravity, but are sucked down by the water, and this hinders the separation of the stones from the coal. It is desirable to give all the time available for the difference in gravities to take effect. If the agitation is slower than that indicated, the machine is not doing the full work of which it is capable, as it is idle during part of the stroke.

This is made clear if we take a diagram such as Mr Rowan has given on page 189.

We deal here simply with the rise and fall of the water and with

the motions of the particles relative thereto. The ordinates in the line of AB (x_1, x_2, &c.), represent the space through which the water rises, and AC represents the *time* of a full pulsation,

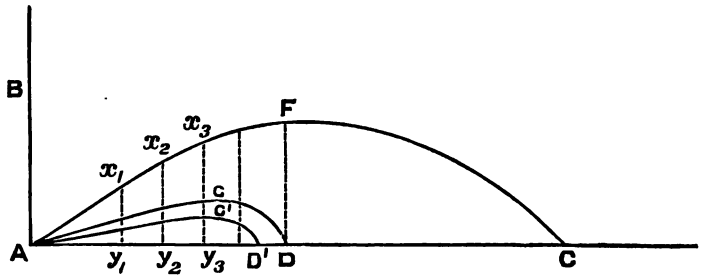


FIG. 1.

AD of half a pulsation. AC also is to be taken as the plane of the perforated plate, and x_1, x_2, &c., consequently show the distances of the surface of the water above the plate at times y_1 y_2. From the description of diagram on page 189, it is plain that the time taken by the particles of coal in traversing the curve AGD is the time that the particles would take to fall from F to D in still water. The time AD must always be the same for a given height (FD) of the water, when gravity is allowed to work alone, and the best result is accordingly got for the reasons given when the stroke turns at F at the time when the last particles have settled on the plate. The water then begins to descend, and it takes the same time to descend that it does to ascend, as while the water is descending in one tank, it is ascending in the other. With this explanation then, and remembering that the velocity of the particles of coal, &c. $= 2{\cdot}44\sqrt{D\ (d-1)}$ we can get a formula to shew how many pulsations per minute there should be to fulfil the conditions of the diagram, Fig. 1.

Let x = number of pulsations per minute and A = height the water rises in the pulsation. Then $x = \dfrac{60 \times 2{\cdot}44\sqrt{D\ (d-1)}}{2A}$

where d = density of pure coal, which takes longest to settle. We divide by 2, because the time of the full pulsation is just twice the time taken by the particles to fall from F to D in Fig. 1.

Suppose, for example, that we have a machine where the rise

of the water is 3in., then taking our formula and the figures on page 192, it will be found that for particles of about 1½in. in size, there should be about 100 pulsations per minute, and for particles about ¾in. in size, there should be about 70 pulsations per minute.

A conclusion that we derive directly from this is that for the same rise of water large particles require quicker agitation than smaller particles. This is contrary to the usual idea. Another conclusion which we may derive is that the smaller the particles the smaller is the rise of the surface of the water that is necessary, and this may be seen plainly by examination of the figures on page 192. The object of the agitation is, of course, to give a reasonable rise to the particles, and we see at once that as the velocity of ¾in. particles is just half the velocity of 1½in. particles, the smaller pieces will rise as high with half the height of water. A further question that is worth considering is the velocity of the water at different parts of the stroke. In the ordinary machine worked with cranks or eccentrics, of course, the quickest motion is in the middle of the upward stroke. The curve is just the curve which shows the different positions of the piston in the cylinder of a steam engine as compared with the corresponding positions of the crank. The formula for the curve (neglecting the obliquity of the connecting rod) is $x = a\ (1 - \cos\ O)$ where a is a constant and O represents the angles traversed by the crank.

It is something of the form shewn on Fig. 2 :—The upward

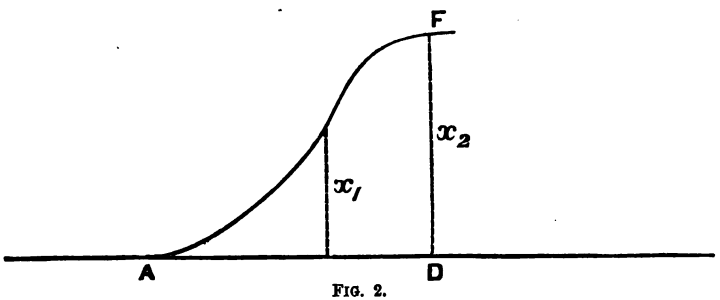


FIG. 2.

motion is slowest at first, which is a bad thing, as the velocity may be too slow to move the particles of coal

from the plate, and consequently part of the stroke may be lost. An ideally perfect machine would be represented by such a curve as in Fig. 3. Here there is an instan-

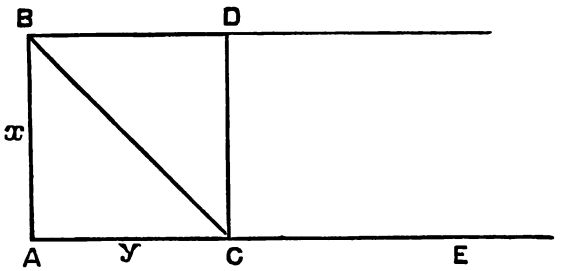


FIG. 3.

taneous rise of the water shewn, and consequently also of the particles of coal from A to B. There is then no motion in the water during the time, *y*, that it takes the particles of coal to fall to the plate; the velocity of these particles is represented as uniform. When the particles have reached the plate, there is an instantaneous drop from D to C. Of course this arrangement is impossible *practically*; but something might be devised nearer it than the present arrangements. Some arrangement of cams instead of cranks or eccentrics might be made. In making these calculations, it may be that there is an error in using the formula given by Mr Rowan as it stands. On page 188 he says that the limiting velocity, represented by the formula, is reached after a period of one second, and in the washing machines, the particles have not a second to fall. The velocity is probably less, therefore, than shewn, and the agitation necessary for best results will also be less than those I have indicated.

Mr HENRY AITKEN said this system of washing with a mixture of air and water was very old. It had been used in America and abandoned. So long as a machine was able to do its work, he did not think there was any advantage in using air. Undoubtedly, if a machine was pressed to get through its work, he believed, by the introduction of air, more work would be got out of the machine, but he thought the cost would outrun the profit. Mr Rowan mentioned that chloride of calcium had been used in wash-

ing coal. He used that substance fifteen years ago for washing parrot coal, but it was not a process that admitted of application, except to a limited extent. He tried also salt brine, but this was not successful. The mixture of air in water was used on a considerable scale in California some fifteen or twenty years ago, but, so far as he knew, this was abandoned, and water or air alone used.

Mr WALDIE said perhaps Mr Aitken would tell them whether the air and water in America was for coal or other minerals.

Mr AITKEN said it was so long ago, he really could not answer. He remembered seeing an account of it, and he looked over it when in America.

The PRESIDENT—It is likely to have been otherwise than coal in California.

Mr AITKEN—I don't think it would be coal washing there.

Mr ROWAN said that when Mr Mitchell said that in practice very fair results were obtained by washing without any preliminary sizing of the coal, he (Mr Rowan) thought that very likely this would be found to apply only to special cases of very pure coal, or to some exceptional conditions. Mr Mitchell's examination of the subject was very interesting, and was a proof of how the interest of a subject may be made to expand in discussion by means of a little effort. It was to be hoped that the example would not be lost, and that Mr Mitchell would more frequently appear and take part in the discussions. At the same time he (the speaker) was not prepared to accept fully all his conclusions, and, in particular, his contention that the water in the washing machines should be at its highest point, and the stroke just turning, when the last of the particles had just come to rest on the surface of the perforated plate. In such a case it was difficult to see what use there could be in having any down-stroke of the water, unless it were for the purpose of filtering the sludge through a porous layer of felspar or some similar mineral. Mr Mitchell seemed to him to forget that if the water in descending sucks the particles downwards, it must do this for all, and must quicken their downward movements in proportion to their several limiting velocities of descent in still water; so that this motion of the water really does not interfere with the

proper separation of impurities from the coal. Therefore, he could not see why Mr Mitchell laid down the rule that the descent of the water must not commence until the last particle had come to rest on the perforated plate. Regarding Mr Mitchell's concluding remarks, he wished to observe that the periods of time in which the limiting velocities of different particles are reached are not the same for pieces of different size and density. One second is stated on page 188 to be the time in which pieces of a given size reach their limiting velocity of descent when water is the fluid. Smaller pieces reach their limiting velocities in less time. Herr Rittinger's investigations proved that these limiting velocities once attained were constant for practically any depth. They would, however, be affected by the size of the vessel containing the water, and probably even in large vessels some difference would be observed near the sides. Mr Mitchell's formula and rule in calculating the number of pulsations required do not provide for the fact that, for different sizes, the stroke or distance traversed by water is, or ought to be, different. Therefore, also, Mr Mitchell's conclusion that larger particles require greater agitation than smaller particles, is only true under certain conditions.

The PRESIDENT said he thought they were greatly indebted to Mr Mitchell for this formula he had worked out. He had evidently taken considerable pains in going over the paper. He thought two most important points in this process were these: the one, touched upon by Mr Rowan, as to the separating of the material to be washed into different sizes, and he had clearly demonstrated how this affected the washing. This element of the trajectory of the water and the particles was another material point, because in all other machines it was by a reciprocating piston. When they had got a machine which worked in the usual way, the piston shoved up the water, and gradually in turning it drew it back. Well, he thought the proper way for a washing machine was to have the water, instead of being actuated by a piston, actuated by a cam. There were machines in existence of that kind. The great fault of the piston was that the water was shoved up and sucked down with the particles, whereas by the cam they had a more perfect system, because the

heavy particles would reach the plate at one moment and the coal would be left above. The one would float and the other fall down.

Mr A. M. GRANT said he had been following those theoretical lines very closely, but he did not think, so far as he had seen, that they applied directly to the machine under discussion, because there was no intermittent action with it. He would like to ask if the lines of the trajectory applied in Waldie's & Robinson's machines where the action was going on continuously.

Mr ROWAN said that the curves showed simply the relative movements of the water and of the particles. They did not give the shape of the path described by the particles.

Mr GRANT said there was a circular motion in Waldie's & Robinson's machine. Would that not affect the line very much?

Mr ROWAN—To some extent, but the diagram gives simply the elements of the case. Taking particles of a different size and density, if they had a still fluid of a certain density, those particles would each fall at a given speed. If they gave the water any movement they liked, they could only give the particles a certain proportion of that movement, just in the proportion which their speeds bore to one another if they were considered as falling in still water. In Waldie's machine, they had this difference, that they had a fluid that was composed partly of air and partly of water, of which they did not know the density; and, therefore, they did not know how the particles behaved when suspended in this fluid.

Mr GRANT did not think Mr Rowan was following the explanation for which he was asking. Besides the vertical motion described, there was a centrifugal force, the coal being put in at the centre and moved by the body of rising water.

The PRESIDENT—The centrifugal force is caused by the stirring.

Mr WALDIE said he was sorry he had not been able to make the experiments Mr Rowan referred to at last meeting. With regard to Mr Grant's question, he could follow Mr Rowan's explanation as far as it went, but at the end of curve, *e*, the action would not be the same as that of a pulsation machine, because there would be the downward fall and there would be more of a continuous forward action. As to the exact density of the air, he had no means of ascertaining.

Mr GRANT said he was presuming that those lines applied only to machines that were worked by a cam or eccentric, and not a crank. Now, the machine they were presently discussing was not a machine of that nature. He could quite follow Mr Rowan and Mr Mitchell in regard to their theoretical lines. Whether they would be exactly borne out in practice, he would not say, but, as he had said, the machine they were discussing was a machine of a totally different nature. Suppose they left out the air in mixing with the water (which in his opinion was really of no great account) he thought the machine was a distinct advance in coal washing, and he would like very much if Mr Rowan would explain, if possible, the action of the water in a machine of that kind, leaving the air out altogether.

Mr ROWAN said he feared there was a little haziness about the diagram, probably because it represented the reverse of the action mentioned in Herr Rittinger's experiments. Rittinger announced the rule governing the rate of fall of particles in still water, whereas in most washing machines, excepting M. Marsaut's, they had still particles and moving water. But it really did not affect the principle, whatever was the kind of movement given to the water. They might have a steady constant upward flow, or an intermittent upward movement, or a reciprocating movement partly upwards and partly downwards, or a combination of any of these with horizontal movement or circular movement, such as was produced by stirring—the elements of the question remained the same. They had simply to reverse in their minds the action studied by Rittinger, and remember that the moving water, whatever was the direction of its motion, could only impart motion in the same direction to the particles in proportion to the difference between the speed of the water and the limiting velocity with which these particles would fall in still water. As to the diagram of trajectories, he begged them to remember that the vertical distances represented, as Mr Mitchell had remarked, the distance through which the water moved—whatever the direction of motion might be—and the horizontal line the time occupied by the movements of the water or particles as the case might be. A little reflection would, he thought, convince them that this diagram represented graphically the relative movements

of the water and of solids, no matter what might be the direction of motion taken by them.

Mr GRANT—But don't you think this centrifugal action, introduced even in still water, has a tendency to float particles?

Mr ROWAN—Do you mean stirring the particles under water or centrifugal force really acting on the particles?

Mr GRANT—The action. The water is swerving to the centre.

Mr ROWAN—Is it moving at such a velocity as would give inertia to the solids under the action of centrifugal force, as it is called?

Mr GRANT said the velocity was twenty revolutions per minute.

Mr ROWAN said, under such circumstances, it was simply a question of giving the water a certain direction of flow. It was not centrifugal motion, properly speaking. In centrifugal machines, such as used in sugar refineries, the speed was several hundred revolutions per minute, and the liquid flew through the perforated sides, and left the solid arranged more or less according to its density in the machine.

Mr GRANT—That is a high velocity.

Mr ROWAN said, if they had a lower speed, they would not be subject to this action. By stirring the water round, either when it was ascending or not, they merely caused the particles to have a compound motion, partly upwards and partly in the direction of the movement of the water, but in strict relation to the movements described in the diagram.

Mr GRANT—So that the centrifugal action has really nothing to do with the washing of the coal?

Mr ROWAN—Nothing, except to prolong the path of the particles, or to direct the particles of different densities to different parts of the machine.

The PRESIDENT—It stirs them up. Referring to previous remarks by Mr Aitken, he asked if he said the brine was too dense.

Mr AITKEN—Was not dense enough.

The PRESIDENT declared the discussion closed, and moved hearty votes of thanks to Messrs Waldie & Stewart and Mr Rowan for the valuable information they had given them, which were heartily accorded.

The following paper on "A System of Endless Rope Haulage at Newbattle Collieries" was read by Mr A. M. Grant:—

A SYSTEM OF ENDLESS ROPE HAULAGE AT NEWBATTLE COLLIERIES.

By Mr A. M. Grant.

THE subject of this paper suggested itself to me, as being worthy of laying before the Institute, after having been engaged in the designing, construction, and erection, and also much interested since in the successful working of an arrangement of endless rope haulage in Dalhousie Dook or incline in the Engine Pit of the Marquis of Lothian's Collieries at Newbattle, near Dalkeith, and which, so far as I am aware, is a distinct departure from the old methods adopted in this or any other district for the purpose of raising minerals from steep inclines or mines, and it also presents in several important points a novelty in endless rope haulage. It has not been my intention, in preparing this paper, to lay before you the results of any exhaustive series of experiments, or minute examination of details, but simply to describe the nature of the arrangements, and the results of working up to the present time.

The top of the incline at Newbattle is situated in "Dixon's" Pit, not far from the bottom of the shaft, which is at a vertical depth of 110 fathoms from the surface, and is driven from this point, at present, in a uniform plane a distance of 580 yards, and its ultimate estimated distance will be about 800 yards on the plane. The hauling engine is placed at the top of the incline in this level (Dixon's Pit), and the full tubs taken off and empties put on the ropes in the engine pit level, 150 fathoms vertical from the surface. The angle of the plane is about 30 degrees, and when the arrangement was first suggested, the amount of material proposed to be raised was 400 tons in eight hours. To do this work it was calculated that a pair of horizontal engines,

coupled, cylinders 14in. diameter and 2ft. 6in. stroke, geared from crank shaft to second or hauling shaft, in the ratio of 7 to 1, would be ample for the purpose. These engines were of the ordinary type, and require no further detailed description. It was then, after careful investigation and experiment, determined to adopt for haulage a form of clip pulley similar to that used at Cadzow Colliery, Hamilton, and on a great many underground and other haulage arrangements in this country, and made by Grant, Ritchie, & Co., engineers, Kilmarnock, and at the same time to use two ropes and pulleys, each going at the same speed, and with each other; and each capable, if at any time it was necessary, of performing the whole amount of the work with perfect safety. Up to this point there was nothing that differed very materially from ordinary arrangements proposed for laying down endless rope haulage, except the using of two endless ropes working simultaneously and at the same speed; but it was when this came to be considered that a difficulty presented itself, which hitherto had not entered into the calculations, namely, that as the clip pulleys are not turned on the inside edge of the clip rings where the rope rides, and the grip on the rope being formed on these adjustable rings, which are formed of hand-chilled castings with a gradual taper or curve which does not allow the rope to touch the bottom of the groove, and also as there could be no possible guarantee that the two ropes could be of exactly the same diameter, and would take up different positions in the groove of the pulley, it would therefore be possible that one or other of the ropes would go faster than the other, and render the system unworkable. To obviate this, it was arranged that each of the clip pulleys should be constructed to run loose on the hauling shaft, and driven by the shaft through friction clutches kept in gear by means of levers and weights, so that they should slip on either of the pulleys whenever the maximum load came upon one rope. In this way the fastest rope would at some time or other take up the whole load, and the clutch slipping would at once allow the load to be again distributed, and the two ropes to go on as before with the work until it was again required. Although this method was adopted as the only one that was practical under the circum-

stances to overcome this difficulty, it was at the same time by no means certain that its application in practice would be a success, as the clutches were in no way under the control of any one. Dependence being placed entirely on the levers and weights, there was a possibility at some time or other of both clutches failing to act at the same time, and as there were no brakes on the pulleys or the engine, the ropes would be reversed and the full tubs go to the bottom with serious consequences. To obviate this, a system of pawls and ratchet was designed (as shewn on the engine plan), which, in the event of such an accident, would sustain the whole load. I may mention here that it was found in practice that the elaborate arrangement of friction clutches was not required, as the adjustment of the speed of the ropes, which really was most essential, was effected in the groove of the clip pulley. It was found that when the speed of one rope was greater than the other it took up the whole load, and the strain being taken off the other one it became slack in the groove of its pulley, when, rising in the groove, it reached a larger diameter, and its speed being thus increased it almost immediately overtook the other rope and resumed its share of the work. The load again became distributed, and the work went on as before.

The next thing that was considered was whether the tubs should be run in sections of two or three or more on the rope, or in single tubs. The latter was thought to be best, and was adopted, as then each could have its own independent attachment, and the risk of breaking away would be diminished. The tubs were attached to the rope as nearly as possible equi-distant, and about 11 fathoms apart. The mode of attachment adopted was the "shepherd's crook," which is well known, and in use on several of the endless rope haulage arrangements in this and other districts—a well-known example being at Bent Colliery, Hamilton. There are four of these "crooks" on each hutch, two on each side near to each end, each let loose into fixed sockets, in the position shewn on the sketch, Plate IX. It will be observed that while the rope is kept from dragging on the pavement, the hook is below the centre of gravity of the tub. This can only be done by two

ropes, unless the tubs are dragged sideways, and excessive friction ensues, as well as having a considerable tendency to pull them off the road.

The engines are placed, as shown on plan (see Plates VII., VIII., IX.), at the top of the incline in "Dixon's" pit, 110 fathoms vertical from the surface, and the tubs are taken off or put on to the ropes in the "engine" pit level, 150 fathoms from the surface. The total length of the incline from where the hutches are delivered is at the present time 220 fathoms on the incline, which is driven perfectly straight both ways, as in ordinary circumstances; and the total vertical height, from the bottom where the tubs are attached to the point of delivery, is 110 fathoms. The ropes are led past the mines at the bottom, and each passes round a large horizontal pulley, mounted on a bogie, which is loaded and forms a good tension apparatus. When a full tub is ready in the full road in the Stone Mine, it is run under the downward or empty ropes, and guided under the full or upward ropes which the crooks or grippers catch hold of simultaneously or immediately after one another, and the tub is hauled to the point of delivery at Engine P. (A on Plate VII.), where the attendant pulls it off the ropes, and sends it to the pit bottom for winding to the surface. As soon as he has landed the tub on the plates at A, he takes out the four crooks from the full tub and passes them on to the attendant at B, who fixes them into the sockets on the empty tub that has been returned from the pit bottom, and pushes it off the plates on to the rails of the incline immediately under the empty or downward ropes, by which it is gripped and let down to the bottom, and taken off in the same way, to be returned again as before.

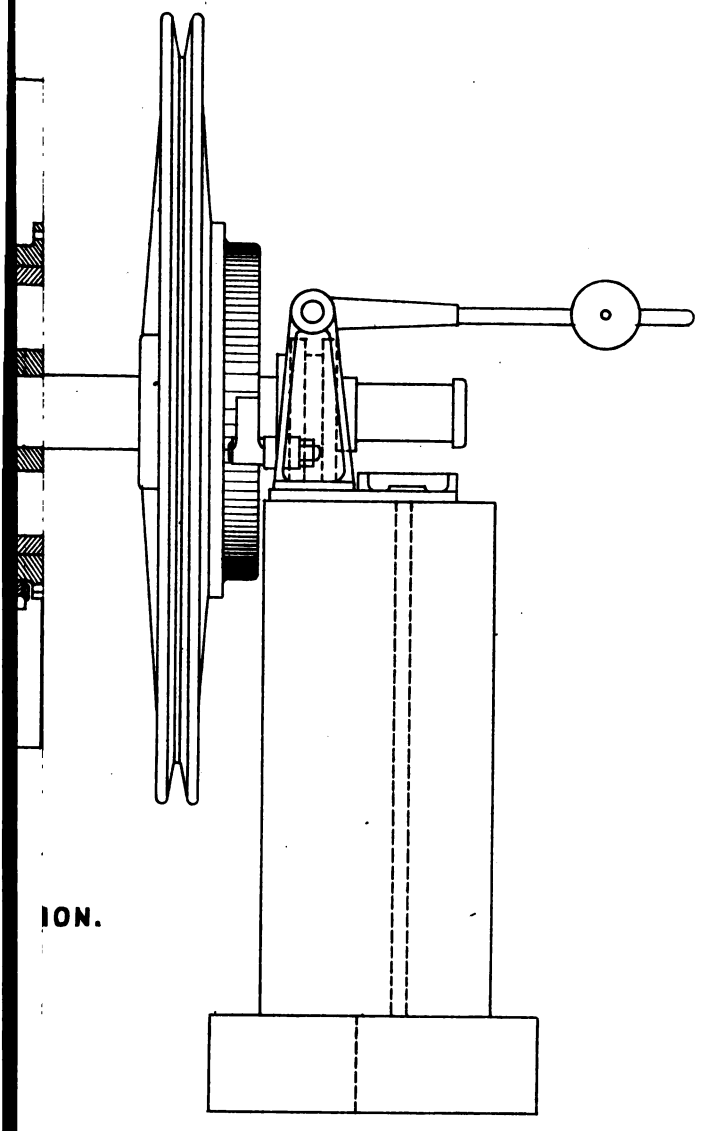
It will be seen from the foregoing description that the mode of working and the details of the haulage differ little from many of the arrangements now in use, with the important exception of the use of double ropes, each of which is capable of sustaining and working the full load. The practical application of this plan, in this installation at Newbattle, makes it obviously much safer than ordinary winding at high speeds on a single rope for the raising of coals from such heavy inclines;

and moreover, while it would be dangerous to run one rope when only slightly worn, it is quite safe to run two to the extreme wear. Owing to this, while the cost of ropes appears to be double compared with winding or tail-rope haulage, such is really not the case, as an inferior quality of rope may be used, and the longer life that may be taken out of it causes the cost from this source to be at least the same, if not less. The ropes at present in use at Newbattle are, I believe, ordinary patent improved steel. They have been in use over eighteen months, and show little signs of wear. To all appearance, they may be used for a long time to come. This system seems also to have several other advantages over winding in cases of this kind. It could as easily be put on the surface as below ground, in a position such as has been described, with a very cheap design of pit or mine head frame, scaffolds, &c. It will also readily be seen that the advantages increase with the distance, as, given sufficient strength in ropes and engines to begin with, the delivery of the material is maintained with the same speed of rope and engine, whatever the distance or depth. The cost of labour in putting on and off the tubs should be about the same as in ordinary level roads, and the risk of accident from breakage of ropes is reduced to a minimum by the use of double ropes and slow speed, as also is the risk from the breaking away of tubs, as it would be almost impossible in the event of breaking away to reach the bottom, the tub being all but certain to be stopped by the next advancing one.

With regard to the work done. The number of tubs on the rope at one time is forty—twenty on the full ropes coming up, and the same number on the empty ropes going down, so that the tubs and ropes are balanced. The weight of each tub is 4½ cwts., and the quantity of coal in the tub 8½ cwts. The ropes are 600 fathoms each, and 4in. in circumference, weighing about 14lbs. to the fathom. The regular daily output is over 300 tons, and this is done with the engine and ropes doing little or no work during about half the time, or running at a much reduced speed. The duration of work is eight hours. But the actual quantity of work that can be done in eight hours is a little over 600 tons, according to the tests made in actual

practical working. Thus, three tubs per minute are delivered at A, with the engine running at a speed of 58·8 revolutions per minute, or equal very nearly to a speed of 2½ miles per hour on the ropes, and with an indicated average mean pressure of steam of 24lbs. on the square inch in the cylinders, which with both cylinders gives a total indicated horse power of about 66. The work done in raising the coals is equal to 2856lbs. raised 660ft. vertical in one minute, or about 57 H.P., or giving an average of about 85 per cent. of the actual work done, leaving only about 15 per cent. for friction on ropes, tubs, engines, &c. The percentage of duty is very fair indeed, and much higher, I think, than is usually obtained in endless-rope or tail-rope haulage, and may be due to some extent to the rope being in contact with so few guide pulleys, which are a fruitful source of loss of power and of short-lived ropes.

In conclusion I may be allowed to mention that the design of the haulage was suggested by Mr John Morison, the manager of the Marquis of Lothian's collieries, Newbattle, and the whole of the machinery was made and erected by Grant, Ritchie, & Co., engineers, Kilmarnock.



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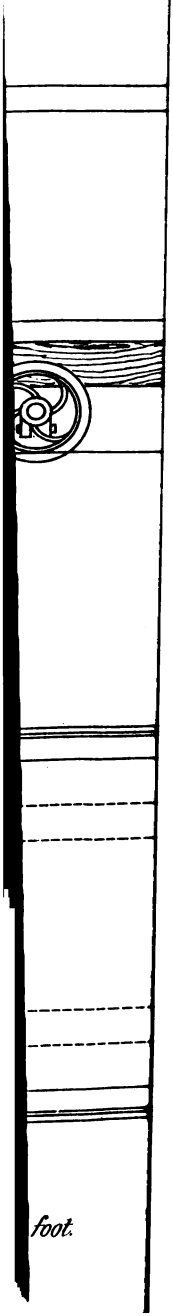

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NOTES ON PAPERS IN TRANSACTIONS OF KINDRED SOCIETIES.

Transactions of the NORTH of ENGLAND INSTITUTE.—Vo . XXXV., p. 175.

COAL MINING IN NEW ZEALAND.

By GEORGE J. BINNS, Inspector of Mines.

THE coal fields of New Zealand are numerous, but of very limited extent, and present peculiar features, fortunately but little known here. The workable seams lie very much higher in the geological section than our own. They belong to a formation having no exact counterpart in Britain; and geologists were forced to add a new term to the science in order to describe it. The rocks have characteristics of both tertiary and cretaceous formation, and so they are classed as cretaceo-tertiary. The coal seams therein are always found at the base of the marine beds of the formation, and interbedded in strata resting with a marked unconformity on the basement rock of the district. Remarking these facts, Professor Lebour compared the geological conditions in cretaceous times in New Zealand with the close of the carboniferous in England, pointing out that the coal strata in both cases were probably preserved by a rapid sinking under the waters of the ocean. Perhaps the most striking fact brought out in the paper is the extreme irregularity of the coal seams, and the consequent great uncertainty attending mining ventures. To take one instance: A seam is described having four feet three inches of coal in three bands, with three feet six inches of "dirt" between. In a distance of seven chains the dirt disappears, leaving a seven feet seam of clean coal. Thirty chains further the seam becomes unworkable, because of numerous partings returning. The coals are for the most part of inferior quality, having a low percentage of fixed carbon, and a very large proportion of water and ash. The best analysis given is as follows:—

Fixed Carbon, ...	63·81
Hydro-Carbon, ...	31·88
Water, ...	3·08
Ash, ...	1·23
	100·00

But fifteen to twenty per cent. of water is not uncommon, and analyses with 10 per cent. of ash frequently occur.

The development of the coal fields has been slow, being retarded by competition with coal from Australia, and by imperfect railway communication and bad harbours at home. In 1884 the output was 480,831 tons, equal to about 76 per cent. of the coal consumption of the colony. The proportion of imported coal burned has been steadily decreasing since 1878.

The system of working almost exclusively adopted is that of board and pillar, and in most cases the small pillars left have been insufficient for the support of the overlying strata, and much coal has been lost. The system on which coal fields have been leased has not encouraged the tenants to secure complete excavation, short leases and no penalty for loss of coal both tending towards wasteful working. Cost of labour is very high, and miners' wages are placed at about eleven shillings per day; but the author thinks the lot of English miners during times of fair trade perferable to that of their Colonial brethren. J. H.

The JOURNAL of the IRON and STEEL INSTITUTE. No. 1—1886.

ON THE PRICES OF STEEL RAILS.

In the course of an address to the Institute in May last, the President—Dr Percy—made the startling statement—which obtained wide currency in the newspapers at the time—that a certain German firm would be prepared, if necessary, to supply steel rails at the low price of 63s per ton. As that statement, unless the meaning of it is thoroughly understood, might produce an erroneous impression on the minds of the British public, Sir I. Lothian Bell made the following explanation:—"It is incorrect to imagine that steel rails can be made cheaper abroad than here, and it was a mistake to say that any German firm had expressed themselves as prepared to ship rails at 63s per ton. So far as he knew, 73s was nearer the price. But some persons might be surprised that German manufacturers could undertake to deliver rails at even 73s, because it might be inferred that they were really able to manufacture rails very much more cheaply than we in this country were able to do, and could, therefore, undersell British manufacturers.

The fact was, that German and other foreign manufacturers stood in a somewhat peculiar position. They levied a duty on all the rails they imported from Britain. The British manufacturer had to add to the market value of his rails in this country the freight, say, to Germany, roughly 12s per ton; he had also to add the duty, 25s per ton, making in all an addition of 35s to the price in Britain, so that in the event of a German railway requiring a supply of rails, a German manufacturer had to compete with English rails on the following terms:—Suppose the price to be 80s in England, to that had to be added 35s, making £5 15s per ton as the cost of English rails delivered in Germany. At that price the German manufacturers undoubtedly had a handsome profit, but, unfortunately for themselves, they had so enlarged their works, that they were able not only to supply the whole of their home demand, but, in addition, one-half more. The German makers, therefore, had to consider whether it would answer their purpose better to lay their works idle to the extent of one-third of the whole production, or keep them going at a loss on this portion of their make. Of course, all producers were perfectly well aware under what disadvantages a concern was kept going when it was not at full work, and partly for that reason, and partly, no doubt, with the view of keeping their men together, the Germans prefer incurring a loss on that portion of their output which they export—a loss which is made good by the high price which they charge to the home consumer.

ON WROUGHT IRON CONDUIT PIPES,

By Mr Hamilton Smith, Jun.

Hydraulic gold mining, which was first introduced or invented in California in 1852, may be roughly defined as the discharge of jets of water actuated by gravity with a considerable head against a bank of auriferous gravel, the water acting as an excavator, and afterwards as a carrier of washed material. The hose for supplying these jets was at first made of heavy cotton duck cloth, strengthened by outer nettings of cordage when the pressure was great. This hose was costly and short-lived, while the cost of cast iron pipes was prohibitive and their use cumbersome.

These difficulties led an ingenious miner to try a line of pipe composed of joints of ordinary stove pipe made of very thin sheet iron lightly rivetted lengthwise with cold rivets, the end of one joint being tightly shoved into the larger end of the succeeding joint with the smaller end pointing down stream. This pipe, which was 5 or 6 inches diameter, answered its purpose admirably, and in a short time all the hydraulic gravel mines in California obtained the pressure for their water jets by means of these sheet iron pipes. As hydraulic mining increased the sizes of these supply pipes also increased, the mine-owners generally making the pipes themselves. After successful practice in the mines had demonstrated the advantages and capabilities of wrought iron pipes, they were used for permanent conduits, both for conducting water to mining districts across

deep mountain gorges, and also for the supply of cities. San Francisco receives its water through two lines of such pipes, and another pipe many miles in length and of large diameter is now being laid for an additional supply. Lap welded tubes of sizes up to 15 inches diameter are now coming largely into use in the United States for conduit pipes. These tubes, which will stand a strain of about 20,000 lbs. per square inch, are almost exclusively used in the western mines for pump columns owing to their combined lightness and strength. The lines of pipe through which petroleum is pumped from the Pennyslvania Oilwells to the seaboard are made of this tubing, generally about 6 inches in diameter. The author thinks the ideal conduit for high pressures is a welded steel tube. Such tubes could probably be subjected to a tensile strain of 25,000 lbs. per square inch with perfect safety, and would be much preferable to rivetted pipe, not only on account of superior strength, but also by reason of almost perfect interior smooth ness; and he directs the attention of British hydraulic engineers and steel makers to th adaptation of a superior and cheap metal such as mild steel, for conduits, which would permit the construction of hydraulic works in many parts of the world, which now appear to be impracticable owing to the cost of many of the methods still in use for the transportation of water.

ON THE ENDURANCE OF STEEL RAILS.

By F. W. WEBB, London and Nort-Western Railway, Crewe.

Referring to the comparative durability of iron and steel rails, the author submitted to the Institute a diagram showing the comparative number of tons of iron and steel rails used for relaying purposes, for the last nineteen years, on the London and North-Western system. On the same diagram there are lines showing the quantities of coal burned in the locomotives; the train miles run; and the engine miles run, respectively. While the coal line follows very closely in proportion to the lines showing the train and engine miles, the line shewing the quantity of rails used for renewals has been a constantly falling one since the year 1877, the year on which steel rails began to be exclusively used. In 1868 the iron and steel rails required for renewals amounted to 16,400 tons, and in 1876 to 31,391 tons, while the estimated requirements for 1886 amounted to only 11,600 tons. The small quantity of rails required for renewals on the L. and N.W. Railway—if other companies have relaid their lines with steel at anything like the same rate—will account to a great extent for the depression in the steel rail trade. As the steel rails wear out, the quantiy of pig-iron required to keep the railway going, will be represented as nearly as may be, by the difference in weight between the rails when put down and taken up for renewal, plus 7½ per cent. in loss for re-manufacture, and a similar percentage will also represent very closely the quantity of iron required for the bath in the Siemen's furnace for re-melting the old steel rails, so that for a considerable time the quantity of iron required for railway purposes will be very much less than it has been during the past period. In the author's opinion, the time has come when steel sleepers should in a great measure fill up the want of orders for steel rails in this trade. The L. and N.W. Company have 45,000 steel sleepers laid down on their system, and the result of a recent inspection of those laid on the Chester and Holyhead line, six years ago, proved that they were in very good order, with no signs of loose rivets, though they were made with a much less chair base and leverage for the rivets than those now being made. A good deal of discussion has taken place as to the tendency of steel sleepers to work end-ways, especially on curves; but this has not been found to be the case when they are properly ballasted. As an instance, Mr Webb mentions that on a portion of the line in the South Wales district, with a gradient of 1 in 88, and on a curve of 10 chains radius, reversing into one of 15 chains, there was no tendency shewn to work endwise. J. P.

Minutes of Proceedings of the INSTITUTION of CIVIL ENGINEERS.—Volume LXXXIII.,—1885-1886,—Part I.

ON THE ENERGY OF FUEL IN LOCOMOTIVE ENGINES.

By GRANVILLE CARLYLE CUNINGHAM, M.Inst.C.E.

The object of the author in this paper is to show by data obtained from different railway companies what is the amount of fuel consumed per unit of work done by locomotive engines; how this consumption varies on different lines, and how the energy of the fuel utilised compares with the full energy; in other words, how much of the energy is used and how much lost.

The consumption of fuel per unit of work done—that is per ton weight moved one mile—is perhaps the most reliable scale by which the capacity of a railway for doing work can be measured and compared with another railway. Thus, if on one line of railway the consumption per ton moved one mile is very much greater than another, it is evident that on the former the gradients and curves, and such elements of resistance, must be more severe than on the latter, other things being equal; of course other circumstances may cause unusual consumption of fuel, such as severity of climate or badly designed or defective engines, but with similar engines working under not very dissimilar conditions, it remains that the consumption of fuel per unit of work may be taken as a certain index of the character of the railway. In an elaborate table accompanying the paper, the author gives the consumpt of fuel per unit of work done on each of the four following lines, viz.: —The Canada Southern, 2·30 oz.; the Michigan Central, 3·52 oz.; the Hannibal and St. Joseph, 5·76 oz.; and the Lake Shore, 2·38 oz.

Though it will surprise most people who have not paid particular attention to the subject to learn that there is sufficient energy in a piece of coal weighing only 2·9 oz. to move one ton weight one mile, yet the investigation would not be complete if it were not ascertained what is the total energy of the fuel and what portion of it is used and what lost. The units of heat (fahrenheit) developed in the combustion of one pound of coal are 14,133, and as the mechanical equivalent is 772 foot pounds per unit, this equals 10,916,676 foot lbs., or 5,455·3 foot tons (American). On the Canada Southern, the average gradient is five feet per mile. This makes the resistance to haulage equal to 11 lbs. per ton; therefore, as much energy will be expended in hauling one ton one mile as in lifting 11 lbs. one mile vertically. At the same rate, 1 lb. of coal would raise 193·6 tons 1 foot vertically. But as shewn above, the full energy of 1 lb. of coal is 5,455·3 foot tons, therefore the full energy is to the work effected on the Canada Southern Railway as 100 to 3·5, and consequently there is a loss of 96·5 per cent. of the energy of the fuel. Though the quantity of 2½ ounces* of coal seems extremely small to do the work of hauling one ton one mile, yet if all the energy contained in it could be utilized and applied to doing work, it would haul one ton twenty-eight and a half miles. A comparison on a similar basis with British railways would be interesting and valuable, but the necessary data do not seem to be available. These figures clearly indicate how much yet remains to be done in economizing the energy developed in the combustion of coal. An engine which wastes 96½ per cent. of the energy with which it is supplied cannot be called perfect. J. P.

* In connection with this subject, the following note may be interesting:—"The S.S. Burgos, trading between Great Britain and China, and built specially for carrying freight cheaply at a low rate of speed, left Plymouth with a cargo of 5,600,000 lbs., steamed to Alexandria, 3380 miles, and consumed on the journey 282,240 lbs. of coal equal to 83½ lbs. per mile; or reduced to the same terms as above, the energy of ½ oz. of coal propelled one ton one mile."

Minutes of Proceedings of the INSTITUTION of CIVIL ENGINEERS.—Volume LXXXIII.,—1885-1886,—Part I.

ELECTRIC LIGHTING FOR RAILWAY TRAINS.

By WILLIAM STROUDLEY, M.Inst.C.E.

A PULLMAN train has been running for some years on the London, Brighton, and South Coast Railway, lighted by incandescent lamps, supplied by accumulators which are charged when the train is at rest, by a dynamo provided for the purpose. This system, not having been found suitable for general purposes, the author and Mr Houghton, the electrical engineer to the Brighton Railway Company, devised a system by which the light is generated by the motion of the train, the dynamo being placed in the brake van with a number of accumulators to store the necessary amount of electricity so that the lamps shall continue to give light when the train is at rest. The dynamo is driven by a counter-shaft connected by belts to one of the axles of the van. All the compartments of a carriage are provided with two lamps, each lamp having separate connections, so that the breakage of one lamp does not interfere with another. A simple form of coupling connects the wires on the carriages, and is so arranged that it separates of itself should the porters forget to uncouple it when shunting the carriages. The light is turned on and off by the guard. The lamp circuit and the accumulator circuit are joined to the dynamo in such a way that when the lamps are alight, and the train is in motion, the current from the dynamo feeds them, the accumulators regulating the light. When the dynamo is out of circuit, the lamps are supplied direct from the accumulators. If the dynamo does not supply sufficient current from the lamps, the balance is given out by the accumulators. If the dynamo furnishes an excess of current, the surplus is stored in the accumulators. Thirty-two incandescent lamps of 16 candle-power each, and absorbing 40 amperes of current, are fitted on each train; and the accumulators, which hold 500 amperes, are sufficient to give out light for eight hours. A train fitted in this way has made 2,352 trips, and ran 27,322 miles. The apparatus can be used for several weeks with no attention except oiling. The commutator-brushes may then require adjusting, which can be done in five minutes, and the apparatus will be ready for use again for a similar period without needing attention beyond that already mentioned. The total weight is about two tons. J. P.

Transactions of the CHESTERFIELD and MIDLAND COUNTIES INSTITUTION of ENGINEERS.—Vol. XIV.

THE AUTOMATIC EXHAUST-STEAM INJECTOR.

By HENRY FISHER. P.p. 291-311.

LIKE its predecessor, "Giffard's Injector," this invention has excited much interest and some incredulity by the recorded results of its use. That exhaust steam at a pressure, very little if at all above that of the atmosphere, can be so used as to send feed water into steam boilers against a pressure of 70lbs. per square inch would scarcely be believed were it not that the exhaust-injector has been in successful operation for several years. The author of this paper details his own experience. Some years ago he encountered great difficulty at Clifton Colliery in maintaining a sufficient supply of steam from six Lancashire boilers, 30ft. by 7ft., fed with cold water in the usual way. This was overcome by using a fuel economiser formed of 200 feet of pipes in the main flue from boilers to chimney. Through these pipes the feed water was pumped to the boilers. The temperature of the water was thus raised from 64° to 141° fahrenheit, and the heated gases in the flue lowered from 495° to 250°. This economiser, when worn out, was replaced at one-fourth its original cost by two exhaust injectors.

Unlike Giffard's, the exhaust injector is perfectly automatic in its action, starting as soon as steam is available, and continuing to act while the supply lasts. Consequently it may be applied even where the supply of exhaust steam is intermittent, as from a colliery winding engine. It causes no increased back pressure in the engine cylinder;

on the contrary, it reduced it by two pounds, in one experiment at least. It can also be so arranged as to feed with live steam when the engines are at rest. The principal precaution necessary in fitting up is to connect it with the exhaust pipe in such a position as to have the steam as dry as possible. For this reason it should be connected to the upper side of the exhaust, and a pipe to drain off condensed water attached beneath it. The water supply to the injector must flow to it by gravitation, but a head of a few inches is quite sufficient.

The temperature of the supply water determines the boiler pressure against which the injector will feed. The lower that temperature the less the quantity of water required to condense the steam. The weight to be set in motion is therefore less, and consequently the higher its velocity, and the greater the energy in the moving water per unit weight. The amount of water sent into the boiler is correspondingly smaller also. When the supply water reaches a temperature of 70° fahr. the injector will no longer act.

At Clifton, the feed water is sent into the boilers at 204° by carrying the feed pipes from the injector along the steam-exhaust pipe. Using live steam at 60 lbs. pressure, the temperature entering the boiler ranged from 150° to 170°. Fed by the exhaust injector, six boilers are now equal to the work done by seven when fed with cold water.

An appendix supplied by the agents of the Exhaust-Steam Injector Company contains the following table of results of experiments:—

	Average with Giffard's Injector Feeding Boiler.	Average with Exhaust Injector Feeding Boiler.
Average H.P., ...	208·385	241·25
Coal—H.P. per Hour.	7·08	5·13
Water, Do.,	7·325	5·11
Water used, ...	8986·75 gals.	8328·75 gals.
Coal, ...	9688 lbs.	8288· lbs.
Length of Trial, ...	6·5 hours.	6·75 hours.

These experiments shew 37·9 per cent. of coal saved by the exhaust, and 43·5 per cent. less water used as compared with Giffard's injector. It is fair to say, however, that this is a special case; and that 20 to 25 per cent. is the economy claimed by the patentees.

NOTES on SAFETY-LAMP EXPERIMENTS. Vol. XV., p. 251.

By A. H. STOKES.

In the course of the discussion on Mr Stokes's paper on the Report of the Royal Commission on Accidents in Mines, it was asserted on behalf of Mr Morgan, the inventor of the lamp of that name, that all the lamps specially mentioned by the Commissioners could be exploded. It was accordingly arranged that experiments should be made before the members of the Institution, by Mr Morgan himself, in order that those interested might see such a serious statement put to the proof. The apparatus used consisted of a foot blower, connected by a flexible tube to a nozzle, similar to an oxy-hydrogen blow-pipe, which was joined by another flexible tube to the gas supply pipe of the building, wherein the experiments were made. Air or gas, separately or mixed, could be directed at the will of the operator upon the lamp being tested. The direction in which the current impinged upon the lamp could be varied without limit. In testing, Mr Morgan's mode of procedure was to direct a current of pure air at a pressure of somewhere about 1½lbs. per square inch upon the lamp from various points till the flame was affected thereby. The gas was then instantly turned on, and the utmost power exerted till the lamp exploded or went out. The result was that each of the four lamps recommended by the Commissioners exploded in from five to thirty seconds, while the Ashworth-Davis and the Clifford lamps withstood the tests applied. No explosion occurred

in the Morgan lamp; but it was shown that gas continued to burn after the wick flame was extinguished. These results appear much more serious than they really are, because the velocity of the current to which the lamps were exposed was something like 300 feet per second, and the direction of the current was in each case nearly vertical—conditions such that the former could not possibly exist, and the latter only in exceptional circumstances in mines. So far as the experiments go to prove anything, it is to show that there are lamps in existence capable of resisting tests under which the Bonneted Muesseler, the Gray, the Marsaut, and the Evan Thomas alike succumb. It is worthy of note that all the lamps that successfully withstood Mr Morgan's test are double bonneted lamps.

J. H.

Transactions of the AMERICAN INSTITUTE OF MINING ENGINEERS.
October, 1886.

THE DUNNACHIE CONTINUOUS REGENERATIVE GAS-KILN FOR BURNING FIREBRICK,

By THOMAS EGLESTON.

IT is a long way round to get from America a description of a new application of an old principle first adopted at our own door. This paper describes the kilns erected a few years ago at Glenboig. The process of brick-burning offers peculiar facilities for an economical application of the regenerative principle, inasmuch as the material being manufactured itself contains the heat for regeneration, and that heat which would otherwise be lost. There is thus much heat saved for regenerative purposes which, in the ordinary regenerative furnace as applied to metallurgical operations, is withdrawn by the material being treated in the furnace. The application of Dr Siemens' regenerative furnace to metallurgical operations almost necessarily implied the adoption of the same principles in producing fire-brick, because bricks burned at the lower temperature of the old process were found liable to considerable change at the great heat common in these furnaces. To burn fire-bricks at a temperature approximating to the highest to which they are likely to be afterwards exposed is, therefore one condition of success. Mr Dunnachie's kilns, started some five years ago, have been the most successful of several attempts in the same direction. They are erected in sets of ten chambers (five in a row), each capable of burning from 12 to 15 thousand bricks. These chambers are connected by flues with a gas producer, and so arranged that the gas can be sent into any chamber at the will of the workman. The kilns are worked continuously. Nos. 1 and 2 chambers are being emptied of burned brick, 3 and 4 are cooling and form the regeneration for No. 5 which is in full fire. To No. 5 chamber then the gas from the producer is turned on and passes thereto by underground flues. On entering the chamber at the floor-level, it meets with the air which has passed through the hot bricks in No. 3 and 4 and has entered 5 at almost a white heat. There combustion takes place and the resulting gases pass on through No. 6 to the chimney, gradually raising the temperature of the bricks there to a bright red heat before its turn to the combustion chamber arrives. Meanwhile Nos. 7 and 8 have been filled with "green" bricks, and are being steamed by burning a small quantity of gas therein with a supply of cold air, and the products of combustion allowed to escape at the top. No. 9 is being filled and No. 10 is ready for filling.

From the brickwork of these kilns there is heat continually radiating. To utilize this radiation a drying stove is placed over the kilns, and the bricks therefrom lowered by a balanced lift convenient to the charging doors of the kilns. The coal used in the gas producers is dross of inferior quality. The average cost of burning bricks in the old Newcastle kiln was 8s 9d per thousand using a good coal, and in the new kilns 2s 9d per thousand using dross. In addition to this saving there is also a considerable reduction in the cost for labour and repair.

The paper contains a minute description of the whole process and detailed drawings of the kilns. There is also a comparative statement of the cost of erecting one set of regenerative kilns and six Newcastle kilns in pairs.

J. H.

Transactions of the NORTH of ENGLAND INSTITUTE of MINING and MECHANICAL ENGINEERS. Part III. Vol. XXXV.

TRANSMISSION OF POWER BY STEAM.

By Messrs LIDDELL & MERIVALE.

THIS paper contains valuable figures, and is a description of the conveyance of steam, at Broomhill Colliery, from boilers on the pithead to a pumping engine underground, for the long distance of 1294 yards. There are two cylindrical boilers, one 20ft. × 5ft., and the other 29ft. × 5ft., used alternately, through which steam is led, at 35lbs. to 38lbs. pressure, in 5-inch cast iron pipes, to the shaft, a distance of 19 yards, down the shaft for 27 fathoms, and then along a road with a vertical fall of 44ft. for a distance of 269 yards to a single cylinder pumping and winding engine of 12in. diameter, running at 30 revolutions per minute for 11 hours out of the 24. With the engine going the pressure is 6lbs. less than at the surface. The exhaust steam from this engine is condensed in the standage. From this point a range of 2½in. wrought iron pipes is carried a further distance of 952 yards, with a vertical fall of 101 feet, to a pumping engine with single cylinder, 8in. diameter and 12in. stroke. The pressure of the steam is here 13lbs. below that in the boilers when the engine is running. This engine was first started with 1240 yards of uncovered pipes, when the loss of pressure was from 27lbs. to 30lbs. with the engine working. The pipes are now covered with Wormald's composition, and those in the shaft coated in addition with felt and sheet lead. The exhaust steam of the inside engine is turned into the suction and gives a vacuum of 13in. to 14in. when the standage is 18ft. below the gauge. There are on the line of pipes two of Tangye's steam traps and separators, and two traps without separators, and these deliver among them 67 gallons of condensed water per hour, or an average of 0·21 lbs. of water per hour per square foot of pipe surface. The consumption of fuel is stated at 38 tons of rough small coal per day.

Among the Foreign Abstracts in this number there is one on

UNDERGROUND ENGINES SUPPLIED FROM STEAM AT BANK.

By M. BAURE.

IN one instance at Bézenet Colliery steam is conveyed to a 10in. engine by metal pipes 3·15 inches in diameter, covered first with felt, then with old hemp, and aloe ropes protected by wood staves, secured by iron hoops. The condensation in the pipes amounted to 35·5 gallons per hour for a length of 449 yards, equal to 0·32lbs. per hour per square foot of pipe surface. In another instance an engine 12 inches in diameter has steam conveyed to it through cast-iron pipes, also 3·15 inches diameter, covered with Magnat's non-conducting cement, which, owing to the presence of water, is protected by a sheet-iron shield, but for 70 yards on the surface the pipes are covered with twisted aloe fibres. The total condensation was 55·3 gallons on a line of 397 yards of pipe, equivalent to 0.56lbs. per square foot of pipe surface per hour. These figures show that the leading of steam for long distances underground is not attended by economy in fuel, although that may be compensated by the small first cost of plant. J. G.

TRANSACTIONS of the MIDLAND INSTITUTE of MINING, CIVIL, and MECHANICAL ENGINEERS. Vol. X. Parts 82-84.

ON COAL CUTTING MACHINERY.

By R. & T. W. BOWER.

THIS paper is a description of a machine driven by ropes. The construction of the cutter is peculiar. On the horizontal main shaft of the machine, a hexagonal cutter bar, forming a continuation of the shaft, is attached by a pin passing through the shaft and

through holes in the socket of the bar. On this bar horizontal washers are placed, which are drilled and tapped for the cutters on every flat, so that there are six cutters on each washer; these cutters are of steel, ¾ inch in diameter, the end being diamond shaped. Thirty washers are required for baring 3½ feet, so there are 180 cutters at work at one time. The end nut keeping these washers in place is also tapped on each side, and carries cutters the same as the washers. The cutter bar makes 500 revolutions per minute, cutting 16 to 18 yards per hour. When the cutters require to be sharpened, the bar is disconnected at the socket and taken to the surface, where the end nut is screwed off, the washers separated, and the cutters sharpened on a grindstone.

The ropes on the face, or between the main roads and the face, have cost $\frac{1}{30}$ of a penny per ton, and the main ropes $\frac{1}{7}$ of a penny per ton. The machine has effected a great reduction in the amount of small, and the cost of getting has been much reduced.

ON THE USE OF ROLLED STEEL GIRDERS FOR SUPPORTING THE ROOF IN MINES.

By Mr Thomas Reader Smith.

Greater durability must be the main reason for the substitution of iron or steel for wood in supporting the roof in mines. Now permanent way rails have been to a slight extent used in Scotland both as crowns and trees, but the economy resulting from their employment would appear to turn on the probability, or even possibility, of their extrac tion after the roadways which they have supported come to be abandoned.

At Thorncliffe Collieries, Iron and steel rails have been used, which sometimes bent gradually, but occasionally broke suddenly with a loud report. During the last two and a half years, doubled flanged rolled girders of mild steel have been used for props up to 6 feet long, and for bars up to 11 feet in length. Two sections are employed—up to 8 feet long, 5″ deep × 3½″ to 4″; and for lengths from 8½ to 11 feet, 6″ deep × 4¼″ to 4½″. In both sections, the web is ½″ thick, and the flanges from $\frac{7}{16}$ at the top to ⅝ at the root. The 5″ girder weighs 27·71 lbs., and the 6″ 24·59 lbs. per foot, costing, at £6 per ton, 13d·95 and 15d·8 per foot respectively. These girders are used in longwall in conjunction with "clog packs," and also in pillaring operations. They stand without bending where the roof and pavement are hard, but sink into a soft bottom, which makes them less easily drawn than props of wood or cast iron; they also cut up the lids to a greater extent. Of course it is as bars or crowns that these girders are most valuable, and they have been used in main roads both through the solid and through "waste" with consider- able success, and given greater satisfaction than the iron or steel rails which had been used previously, bending 8 or 9 inches in the centre of an 8 feet span without showing signs of fracture. Out of some thousands in use, only nine had broken. J. G.

THE JOURNAL OF THE BRITISH SOCIETY OF MINING STUDENTS.
Vol. IX. No. 6.

LONGWALL WORKING AT SEATON DELAVAL.

By Mr GEORGE HURST.

This is a description of a longwall working in a perfectly clean seam, averaging 2ft. 7in. thick, with a roof of post or blue metal with post girdles, and a 'seggar' or fireclay pavement, lying at a depth of about 60 fathoms and at an inclination of 1 in 18. The main levels and heading roads are driven in pairs, 14 to 15 yards apart, holed through every 44 yards, and protected by barriers of solid coal 35 yards broad, with a view of lessening the cost for timber and preventing scaling of the air. The walls are 11 yards wide, the packwalls 6 feet broad, and cross-roads are formed through the waste every 60 to 100 yards, and other details correspond with ordinary Scotch practice. The miners are paid on round coal alone according to the following sliding scale :—

Thickness.	Rate.
2ft. 8in., ...	2/5
2ft. 9in., ...	2/3½
2ft. 10in , ...	2/2
2ft. 10in. to 3ft. 0in., ...	2/1
Above 3ft. 0in., ...	2/0

And the cost of production per *gross* ton is stated to be—

Hewing, ...	1/7
Yard Work, &c., ...	0/2
Overmanship, ...	0/2
Putting, ...	0/1½
Driving, Rolleyway men, &c., ...	0/3½
	2/6
Stone Work, ...	0/9
Waste, ...	0/0½
Timber, ...	0/1½ to 0/2
	3/5

PILLAR WORKING IN THE NORTHERN COALFIELD.

By Mr H. F. BULMAN.

By the help of diagrams, very clear descriptions are given of the methods of extracting pillars of different sizes and under varying conditions as to the roof being 'fallen' and otherwise, so as to secure their removal with as little narrow work as possible. The author's experience is that the system most in favour "is that of boardways (planecourse) lifts driven half-way along the pillar, right and left from every headways (end) course."

Regarding the difficulty of working two seams separated from one another by only a small thickness of stone, the writer thinks "that when the intervening stone is firm and adhesive, it is best to work the top seam first, allow the roof to settle, and then work the lower seam; but where the stone is loose and friable, the bottom portion should be first attacked, as otherwise it may be found impossible to work it at all."

The complete removal of pillars in very thick seams is attended with almost unsurmountable difficulties, and Mr Bulman gives an interesting description of a working at 28 fathoms deep of the following section which came under his notice :—

Five-quarter,	Good Coal, ...	7ft. 9in.
	Splint Coal, ...	2ft. 3in.
	Soft Band, ...	1ft. 0in.
Brass Thill—Good Coal,	.. .. ..	5ft. 1½in.

"The brass thill was worked in the 'whole' first, the pillars being made 30 yard bords (plane) by 8 yard walls (end). In working the 'broken,' they cut up into the five-quarter from the bord (plane) in the brass thill, at a point about 7 yards back from the inbye end of the pillar, and drove a siding over (end) 2 yards wide in the five-quarter. The block of five-quarter, 7 yards by 8 yards on the goaf side of the siding over, was then removed in the two bordway lifts. The same process of cutting up, siding over, and working off the lifts is repeated twice, leaving a piece 3 yards by 8 yards to be worked. This is done by driving a jerkin (split planeways) in the brass thill pillar 3 yards up from the headways, and breaking up into the five-quarter when the remaining stooks are removed. A jenkin 6 yards wide is then continued up the middle of the brass thill pillar, leaving a yard of coal on either side. When the old bords are fallen a jenkin 4 yards wide is first driven up the brass thill pillar. A great deal of coal is lost, perhaps unavoidably. The reason for making the walls in the brass thill only 8 yards is that in working the five-quarter the coals are filled into the tub standing in the brass thill bord, and where there are more than 7 yards to cast the coals extra wage has to be paid for it." J. G.

Transactions of the AMERICAN SOCIETY of MECHANICAL ENGINEERS.
Vol. VII., 1886.

THE President's address is racy of the soil. He attempts to show that the mechanical engineer is peerless not only among engineers, but among all other men as well. While the civil, naval, and military engineers may plan works, ships, and defences, the mechanical engineer is called on to devise the tools and machinery with which they are constructed; and the mining engineer would sit helpless above his earth-bound treasures did not his mechanical brother come to his aid to lift them from the mine or smelt them from their dross! Mr President is responsible for the statement that during the Reil rebellion an American firm, manufacturing a rapid-firing multiple gun, sent an agent to the scene of strife, who, running his machine far to the front, and all unmindful of the storm of bullets coming from the foe, turned his crank with such unceasing energy, that he actually won the battle before the regular soldiers had a chance of firing a shot!

The volume contains many readable papers, some of them very technical, and others quite as general. Among the latter may be noticed **"THE UNEXPECTED WHICH OFTEN HAPPENS."** Its aim is to show that things perfectly familiar to people employed in one industry are sometimes something of a surprise to men employed in another. Take for example the air-trap. A cistern in the roof has a pipe from its bottom to the cellar and up to a basin. When the cistern has been emptied and again filled air is trapped in the pipe, and if the basin cock is opened the water will not force the air out. The plumber says it is an air-trap. You venture to suggest that the water should force the air out. The plumber says "It is an air-trap and how can it?" You say "By gravity;" and he says "Oh!" And you finally come to the conclusion that possibly he knows just as much about what an air-trap is as you know about gravity, and no more. An experience of many things of this kind causes the author to think that engineers and others should "saturate all their statements and speculations with the elements of uncertainty."

Among papers of quite another stamp are the **"ENGINEER AS AN ECONOMIST,"** and the **"SHOP ORDER SYSTEM OF ACCOUNTS,"** dealing with the method of administering the affairs of large works, apart altogether from the technical operations carried on in them. There is also a capital article entitled **"INVENTORY VALUATION OF MACHINERY AND PLANT,"** which shows a method of arriving at results in advance of the popular and frequently used process of pure guesswork.

J. G.

JOURNAL of the SOCIETY of CHEMICAL INDUSTRY. January, 1887.

KINETITE.

By Mr WATSON SMITH.

THE writer has collected much information regarding this explosive, the advantages claimed for which are that it is stronger than ordinary gunpowder, less dangerous than dynamite, and being easily mixed, and such mixing unattended with danger, its constituents may be transported without risk to where required before being brought together. Its composition is:—

Nitrobenzene, ...	16	to 21	per cent.
Guncotton, ...	¼	to 1	,,
Alkaline chlorates and nitrates, ...	75	to 82½	,,
Sulphur, as antimony pentasulphide, ...	1	to 3	,.

The small percentage of guncotton is, of course, explosive, but when it is mixed with the nitrobenzene it forms an inexplosive gelatinous mass. English and German experts report favourably as to its safety, stability, and to its possessing the property that any disincorporation would result, quite unlike dynamite, in the formation of a material less explosive than itself. Nevertheless, the Secretary of State refuses to sanction its manufacture in this country, principally on the ground of its want of chemical stability, and its extreme sensitiveness to combined friction and percussion—such as is

given by a glancing blow. The glaring difference of opinion between Dr. Dupré, the Home Office chemist, and the other experts employed by the patentee, is probably accounted for by the latter gentlemen being "in a position of greater freedom and lesser responsibility." J. G.

Transactions of the AMERICAN SOCIETY of CIVIL ENGINEERS.

ON INCREASING THE ACCURACY OF A SYSTEM OF MAGNETIC BEARINGS OF A SURVEY.

By O. H. LANDRETH.

THE object of the system advocated in this paper is to assign magnetic bearings to the angles taken by a theodolite "which must conform to the vernier system by giving angles between adjacent courses identical with the corresponding vernier angles." The leading features of the method are thus summarised by the author.

1st. Measure and record the traverse angle at each station referred to the first line of the survey as an origin.

2d. Observe and record the magnetic bearing of each line, taking as such bearing the average of the bearings taken at the two ends of the line.

3d. Apply the traverse angle, with its sign reversed at each station, to the magnetic bearing of the line starting from that station, by so doing forming a series of bearings of the first or origin line, each transferred from a separate line of the survey.

4th. Take the arithmetical mean or average of the several values of the bearing of the first side as the adopted bearing of that side.

5th. Apply the traverse angles, with their true sign, in turn to the adopted bearing of the first side, giving, respectively, the corrected bearings of each side.

In the discussion on the paper, it was pointed out that where, owing to the geological character of the ground, there were numerous local attractions, the system would be of no value, and that, in all extensive surveys, these attractions are such as to render needle work far from reliable. A. L.

Transactions of the ENGINEERS and SHIPBUILDERS in SCOTLAND.

IMPROVED ENGINE REVOLUTION COUNTER,

By Mr M. T. BROWN, B.Sc.

THE author described Kaiser's Patent Revolution Counter, two forms of which were exhibited.

The general features of this counter, which he claimed as improvements of those counters generally in use, were:—

1st. The method of locking the number wheels after each successive movement. This is accomplished by means of a projecting rim on the number wheel passing between the overhung teeth of the pinion, which latter cannot move till a gap which is in the rim comes round opposite the pinion, and so relieve it, a single tooth on the boss of the number wheel at same time gears into and moves the pinion one tooth forward equal to one-tenth of a revolution.

2d. The higher number wheels, which have in ordinary circles to move very seldom, cannot get set fast by corrosion on the axle. The axles, both of the number wheels and pinions, in the Kaiser counter are carried right through from end to end, and move with each stroke of the engine, thus keeping them free.

3d. The stroke of the driving lever does not need to be limited, as the motion is so arranged that the driving shaft may either simply oscillate, or rotate forwards, or backwards, the resultant motion of the number wheels being the same in each case.

The driving shaft actuates a small crank, the pin of which works in a slotted lever, and this slotted lever is secured to a segmental ring, to which it gives a reciprocating motion. The segmental ring in turn gives motion to a toothed wheel on the axle that carries the train of number wheels. The teeth of this wheel are shaped as in a clock escapement, and the motion is really a clock escapement reversed. A. L.

MINES INSPECTORS' REPORTS, 1886.

The following extracts from the Reports of H.M. Inspectors of Mines, for the year 1886, refer to some of the more prominent defects in present mining practice, and indicate the directions in which, in the opinion of these gentlemen, further legislation and efforts towards safety should tend. J. B.

MR DICKINSON, Inspector for North and East Lancashire, &c.

The question of prop drawing with the ordinary miners in the pit, as illustrated by this explosion at Crumbouke Mine, was raised at the inquest, and has since been considered by the inspectors of mines at their annual meeting. The inspectors are of opinion that the question, if met at all, should be by special and not by general rule, as it would disarrange work in some instances, and in others be dangerous from shot firing, &c.

On Wednesday morning, 8th of December, the pressure indicated by the barometer was as low if not lower than has been experienced near Manchester for many years. The consequence was the expansion of fire-damp and issue from goaves or worked-out spaces in collieries, three instances of which came to my knowledge. In one of these the manager, early in the morning, noticing the rapid fall and the wild state of the weather, anticipated what would occur and sent a note down the pit, but the firemen had found the gas and the miners were cautioned, which occasioned its being brought under my notice. In another colliery the expansion from a large goaf was such that work was discontinued for that day. In the other the gas showed through stoppings where it was built off. Other instances may have occurred without my hearing of them. These instances, if they were needed, confirm the relationship between atmospheric pressure and such expansion, and that a goaf is perhaps the most sensitive barometer. What is called a "colliery warning" appeared in the newspapers next morning, but the gas had then disappeared. No explosion occurred, the precautions required to be taken daily having discovered the issues.

For some years before the report of the Royal Commissioners on Accidents appeared the necessity of something being done to guard against the increasing velocities of air currents in collieries had occupied the attention of mining engineers, and in fire-damp mines in this district the use of safety lamps was extending, and the Protector Mueseler lamp was in use, and the Marsaut introduced in 1883. These and similar lamps which give good light, and are capable of resisting such explosive currents as are likely to be met with, are gradually supplanting the Davy for working with; but the Davy is still generally preferred for testing, and by some practical persons it is still considered to be under all the circumstances the safest lamp. In many collieries the Davy lamp is being used with the glass shield extended to about quarter of an inch above the bottom of the cap gauze, which gives greatly increased security. The great explosion in the Wood End Pits Bedford Colliery, indubitably fired through a Davy which had a screen that encircled only two-thirds of the lower part of the bottom gauze. The Davy, therefore, with such a screen, or with a screen encircling only part of the lower gauze but not to a little above the cap gauze, should not be used in gaseous mines where a quick current may be met with.

Improved lamps are now so numerous that the main difficulty is in the selection.

MR WYNNE, North Staffordshire.

I have witnessed exhaustive experiments in the use of the lime cartridge, in Settle's water cartridge, and in Heath's and Frost's gelatinous cartridge, and in each case my opinion formed from what I witnessed was that, with careful use of them, they are perfectly safe; and that, *now*, the use of blasting powder in fiery mines is recklessly endangering the lives of the workmen employed therein, whether they be called firemen or by any other name.

Bore holes should be enforced as much when approaching an accumulation of gas as of water.

Much has been said and written upon the subject of lamps, and no doubt it is a most important subject, but I am certainly of opinion that the questions of a proper ventilation and the disuse of ordinary blasting are more important to miners, and I do not consider it the duty of an inspector of mines to give any opinion on the varying merits of different lamps that now claim the attention of colliers.

MR STOKES, Midland district.

Some of the deaths from falls are due to circums ances which appeared beyond the control of human foresight; but others possibly might have been prevented if the men had used proper and adequate supports.

In withdrawing old timber from the goaf, men should always use a "ringer and chain," and not, after knocking out the prop, go under the unsupported broken roof to get the timber out with their hands.

MR MOORE, East Scotland.

With regard to the comparative safety of the long wall, and stoop and room methods of working, a table is given, which shows that where coals were worked on the stoop and room method, 324,185 tons were raised for each life lost, and where coals were wrought by long wall, 271,990 tons were raised for each life lost, showing the advantage in point of safety to be in favour of the stoop and room method.

As usual the greatest proportion of the deaths was due to falls of roof and sides. I have frequently stated my views on this point, that the owners should appoint special men to prop the roofs at the faces where most of these accidents occur, and I am still strongly of opinion that this would tend to safety.

It is very desirable that there should be some simple test as to when safety lamps should be employed without having recourse to arbitration, which is always a slow and cumbrous tribunal. I admit it is not a very easy matter to fix this so as to give satisfaction to all parties, because in some collieries in this district where only a small amount of gas is given off, the owners think safety lamps unnecessary throughout the whole colliery or seam, and that it is a great hardship to put them all on safety lamps. In others where there is more gas the owners in many cases are equally reluctant, and say that the ventilation can be so managed as to prevent explosions. On the other hand, there were 37 explosions in this district last year, all of which would have been prevented by the use of safety lamps. By one of these one man was killed, while by the others 37 persons were injured.

Perhaps a simple test would be the presence of fire-damp in a seam twice within a certain time; thus, if fire-damp were seen twice in any seam during three months, then safety lamps should be put on for three months. Some such test as this would be very simple, and I do not think that it would be unduly hard upon anyone.

The objections of the owners to use safety lamps, are that the safety lamp gives little light, and that the collier does not see so well to clean his coals. No doubt there is something in this objection, but there is really less ground now than there was, to complain of the quantity of light, because many of the new and improved lamps give a light little inferior to a common open lamp. Another objection is, that the light, even if as good, does not shine on the roof, and that the miner cannot detect the insecurity of the roof as well as he can by an open light which shines all round. I believe there is no ground for this objection. Falls of roof occur either from the negligence or ignorance of the ordinary miner to support the roof, and because the miner depends on his own judgment to detect the state of the roof. Most people who have inquired into accidents from falls of roof as an inspector does, will agree with this. I am satisfied that the best means of reducing the death-rate from falls of roof is to employ skilled men to set up props at regular intervals, whether they appear to be required or not, and this could be done as well with safety lamps as with naked lights.

The lighting of mines by means of the incandescent electric light is still being aimed at by inventors and seems to be getting beyond the experimental stage. If a cheap and

handy lamp of this kind can be got, and it appears to be only a work of time, it will be one of the greatest benefits conferred on mining since the introduction of the Davy lamp.

There was no new or striking improvement in mining during the last year, but there is undoubtedly a gradual improvement going on in the management and discipline of mines which will tend to still further reduce the number of accidents. There always will be loss of life in mining. It is a dangerous occupation, and requires the greatest care and forethought to reduce the number of accidents to a minimum.

MR WARDELL, Yorkshire.

On the 2nd October the district was startled and shocked by the tidings of an explosion at Messrs Pope and Pearson's colliery at Altofts, near Normanton.

About 40,000 cubic feet of this quantity passed along the West Chain road, and it was on this road that the explosion originated. Nine men were engaged about the end of "Roper's drift," on this intake airway in straightening the road, and were using gunpowder for this purpose, to blast the stone. From the evidence, and from appearances afterwards, three shot holes had been drilled and the shots fired. All the holes had been badly planted, and the last of them, in all probability, had caused the explosion. Two of the shots would seem to have been fired without any disastrous effects, beyond filling the airway with fine particles of coal dust, for the mine is exceedingly dry and dusty. The third shot, owing to the unskilful drilling of the hole, only partially did its work, and, although it was not a blown-out shot, would cause a large diffusion of flame, and the roof, floor, and sides of the road being covered with dust, as well as floating particles in the air from the cause I have mentioned, ignition would take place, and the explosion ensued.

Such a small percentage of gas may be mixed with coal dust as to be practically undiscernable, and which cannot be detected by the ordinary test of a safety lamp, and yet this forms a highly explosive mixture. In this instance, however, it is very difficult to believe that there could be even so small a quantity of gas, for there was a current of fresh air of about 40,000 cubic feet per minute passing along the road when the shots were fired, and there did not appear to be any place near where gas could have lodged or accumulated. The general opinion coincided with my own, that the explosion was one of coal dust; and at the inquest the jury returned the following verdict: "That the whole of the workmen killed, except the two deputies, met their deaths from an explosion of coal dust which originated in the West Chain road, which explosion was caused by the firing of an unskilfully-drilled shot by one of the workmen engaged in widening the road. That the two deputies were suffocated by the stoppage of ventilation consequent on the explosion."

Dust is not admitted by all to be in itself sufficient to cause an explosion; but at any rate, all are pretty well agreed that it intensifies and aggravates the effects to a very great extent; and it must therefore be regarded as an element of danger, and should be dealt with as such. All effects of the explosion at Altofts were confined to the intake roads. The returns were undisturbed, and the coal faces were just as when the workmen left them. Wherever coal dust ceased there ceased also all trace of the explosion.

I am of opinion that the best-known detaching hooks should be in operation at all collieries, and I think an improvement would be effected which would tend to promote increased safety were enginemen to be doubled; at any rate there should be two in the engine-house whenever men are ascending or descending.

It seems to me further, that an additional precaution might be effected by adopting a second set of "fallers" (or shuts) fixed immediately below the catch-plate of the disengaging apparatus, so that directly the cage becomes detached from the rope these "fallers" would hold it without the risk of their being broken by the cage falling on to them from any height.

The work of the St. John's Ambulance Association, so far as it is connected with collieries, contiuues to prosper in this district. Indeed, it has so extended, that it is

difficult now to go far without finding established a well-disciplined corps. The object —that of rendering first aid to the injured—is one to be encouraged and assisted in every way. During the past year, within my own personal knowledge, cases have arisen in collieries, where it is, at any rate, doubtful whether the injured persons would have recovered had it not been for this "first aid" rendered on the spot and at the time.

MR WILLIS, Newcastle-on-Tyne district.

It would be easy, I think, from the above to found a good argument that wherever gas is known to exist in a mine no lights other than safety lamps should be permitted in the workings. It is true the quantity of gas may be very small, but on a somewhat similar principle a person suffering from a contagious disease is none the less isolated and disinfectants are none the less used because the attack is a mild one. When I have felt it my duty to advise the use of safety lamps in pits where small quantities of gas are given off, I have frequently been met by the argument (apart from the commercial aspect of increased cost of production and diminished facilities for cleaning coals) that in consequence of the comparatively feeble light of the lamp the danger arising from imperfect examinations of roof and sides would tend to a greatly increased number of accidents from "falls." I am satisfied, that if sufficiently detailed statistics were available, it would be found that the death rate by falls is not greater, and probably not so great, as where open lights are used.

Allowing for the larger number employed, the death rate from falls is still somewhat greater in Northumberland, where open lights are the rule, than in the Durham portion, where safety lamps are almost exclusively used. To consider the death rate from falls as being equal, whether safety lamps or naked lamps are used, it fairly follows, I think, that, had the use of safety lamps where gas is known to exist been compulsory, in this district at any rate, we would not have had eight instances of scorching or burning men, and would not have had a greater number of accidents by falls.

I have ascertained that in Cumberland, where women work about the screens, they are occasionally allowed to attend to placing the waggons. This should not be permitted, and I have had an opportunity of suggesting that this be prohibited in any future Mines Act. I believe such prohibition has been introduced into the Bill now before Parliament, and I apprehend there cannot be any objection raised to it in the future stages of the Bill. With this exception, as I have mentioned in previous reports, I see no impropriety, either physically or morally, in the employment of women about the mines, proper regard being, of course, as at present, had to their being kept apart from the men during mealtimes and at other times when retiring from work.

The obligation under the Metalliferous Act to provide a "dressing room" where the workmen may change their clothing upon leaving work has been productive of much good in this district. Probably the original intention in this, as set forth in the rule itself, was for the convenience of the workmen where the mine was very wet getting their clothes dried before going home. In the larger mines, however, such convenient places have been erected, with abundant supplies of hot and cold water, drying tables, bath tubs, &c., &c., that all the men, whether working in dry or wet places, change the whole of their clothing, leaving their working clothes in the dressing room until next day. The larger dressing rooms thus fitted are in charge generally of a man, and in some cases, where the mine works continuously, of three men, to keep the place clean and comfortable. Of course all this is at the expense of the owner.

DR. C. LE NEVE FOSTER, Wales. (Metalliferous.)

I frequently have to complain of dynamite and similar explosives being taken underground without any proper substantial case. A paper box is considered sufficient by many miners; and I have seen dynamite stowed away in a worn-out shoe and in an old teapot. I fear I shall not be able to enforce the use of secure cases until some of the managers have been prosecuted.

Irregular and dangerous methods of thawing dynamite are often resorted to instead

of using proper warming pans. Three men were slightly injured at Roman Gravels mine last January rom the explosion of some dynamite remaining in a can of water in which they had been heating their cartridges; and a few weeks ago I myself discovered dynamite being heated in a tin over a lighted candle. It is true that in this case the tin containing the cartridges was placed in another full of water; but if either receptacle had leaked—and no one can vouch for the staunchness of an old and battered meat-tin—an explosion would very likely have occurred.

MR BELL, Durham district.

The falls in the Cleveland ironstone mines are now more frequent, as the bulk of the stone is got from pillar working; and owing to the great height of the seam, the roof is difficult to examine with the small light of a safety lamp, or even with a candle. I trust that in future legislation the rule as to lighting in such mines as these, where inflammable gas is only occasionally seen, will not be too tightly drawn, because, by restricting the amount of light, you prevent a thorough examination of the roof being made by the deputy or responsible person, and the miner cannot see to do his work properly, or see so well when there is danger from falls either of side or of roof. If the safety lamp rule as now drafted in the new Mines Bill is to be applied to the Cleveland mines as strictly as it has to be applied to the fiery coal mines for three months after any gas has been seen, I am convinced that the accidents from falls in Cleveland will soon be more than doubled. The enforcing of this rule would also necessitate the enforcement of the gunpowder and explosives rule, as it does in the case of coal mines, where gunpowder, &c., has to be used only at nights, or when the persons ordinarily employed in the mine are out of the mine, or out of the district where it is to be used. Such a rule as this would be totally impracticable in the Cleveland mines, and could never be carried out.

I again beg to repeat, what I have often stated in these reports, and I say it most emphatically, that such a large number of fatal accidents ought not to take place on the surface as we are accustomed to record every year, if only proper means were adopted to make room for a man to pass between the waggons and the projecting screen legs or pillars. At three-fourths of the mines in this district there is not sufficient room for a man or boy to so pass, and this is the cause of so many lives being lost. Besides there is a large number of bodily injuries, caused in this manner, annually reported; and while attention has frequently been called to this, both in reports and during official visits to the mines, there does not seem to have been much notice taken of it.

The moving of railway waggons on the branches or sidings, on the surface, by boys of tender age, is another fruitful source of accident, and in my opinion the employment of boys and women for this purpose should be prevented by Act of Parliament.

MR HALL, West Lancashire.

The timbering of the working places is left almost entirely in the hands of the colliers themselves, and the repetition of the set phrase "you must take care of yourself" is in many cases the amount of the official's interest in the matter. In 1884 I reported that suitable timber was generally at hand for the workmen to fix up, but recently many cases have occurred where it appeared that the workmen had great difficulty in procuring a supply, and that they were tempted to continue working in places not entirely safe. It is true that there is a special rule ordering the men to leave any dangerous working at once on the supply of timber running short, but we know they are paid for the amount of coal got, and time lost hunting for timber, or through having to cease work when they are unable to get it, means to them an important money loss, and to place them in this position is a certain method of adding to the death-roll. I am of opinion that, in districts where the timbering is left to the miners and is included in the price of coal-getting, the law should be made stricter both as to the supply of timber and also as to the manner in which it shall be fixed up.

I feel very strongly that any fresh legislation, if it is really brought forward with the

object of making the miner's life less hazardous, must be directed to three important subjects, viz., blasting with gunpowder, timbering, and safety lamps, and small inconveniences which a stricter law on these subjects might entail, must not be allowed to stand in the way. The objections that are urged in many cases are very fanciful, and would entirely disappear in practice, and those that spring from a bad and dangerous system of mining, however long such system may have been adopted in a mining district, can have no claim for consideration whatever.

MR RONALDSON, West Scotland.

It is gratifying to report that no fatal explosions of fire-damp took place, as this is the first year since the passing of the Mines Act of 1872 that such a result has been got. There are only two collieries in which safety lamps alone are used. In a few others, for ordinary work, safety lamps alone are partially or occasionally employed, and as fire-damp is given off more or less in a large number of mines where naked lights are in use, immunity from explosions can only be approached by careful distribution of good air-currents and strict attention on the part of all concerned to the carrying out of the rules. So long, however, as naked lights are used in mines subject to fire-damp, it is too much to expect that explosions will be entirely avoided. Although the number of non-fatal explosions reported was only 22 as compared with 26 the previous year, and resulted in the injury of 35 persons, investigation into their cause showed that many of them were due to disregard of the rules or want of proper caution, generally by the sufferers themselves. As a whole, the ventilation of the mines is much better than it was 12 years ago, and this, together with a more rigid compliance with the General and Special Rules, has no doubt tended to produce the substantial reduction that has taken place in the number of explosions. In the year 1874, there were only nine fans used for ventilating mines in the whole district, and now there are 109, while there are still 117 mines ventilated by furnace or other means.

By falls of roof and sides there were 24 fatal accidents, or 68½ per cent. of the total number reported. Of these, 10 were by falls of side, and 14 by falls of roof. By referring to the table before mentioned, it will be noticed that during the last 14 years no improvement, taking into consideration the number of persons employed, in reducing this fruitful source of accident has been made, and I am thoroughly convinced that, until a radical change is made in the hap-hazard system of guarding against falls, little improvement may be expected. Of the 14 falls of roof, no fewer than 11 took place at the working face, where such accidents require to be specially guarded against. Setting props where the roof is found to be unsafe is a good thing, but experience has proved that this is not enough. If the workmen always knew when the roof was insecure and at once put up props, this system would be sufficient, but too often it is a danger unknown to the most skilful that has to be dealt with, and it is to meet such, if the number of these accidents is to be lessened, that precautions must be taken. I see no remedy except the simple one of setting props or otherwise securing the roof at the working face at regular intervals irrespective of the appearance of the roof, so that no part exceeding a definite specified area would ever be left unsupported. When the roof was found to be still insecure inside this area, additional props would then be set. A general rule to this effect, and one that also would apply to "spragging" the working face while being holed, would be productive of good results, and, so far as this district is concerned, would entail but little hardship in any instance.

Twelve accidents by powder while blasting or otherwise were reported, and I consider that six of these would not have happened had the explosive been in cartridges instead of being taken into the mine loose. When loose powder is used, there is the danger of its being ignited unexpectedly by a spark from a naked light or a pipe, for in handling powder workmen do not always use the precaution that is necessary, and I have known several instances of premature ignition while stemming shot-holes, which there is every reason to believe were occasioned by loose grains of powder lying along the bottom of the hole being exploded by the friction caused by the stemmer.

I am of opinion that a rule should be introduced making it imperative at all mines that explosives be taken below ground and used only in cartridges. Many accidents would thereby be prevented, and seeing that drilling machines which make circular shot holes are now so extensively used, there would be but little hardship in introducing such a rule.

MR CADMAN, South-West District of England.

The principal safeguards on which miners must rely against these accidents are careful and intelligent attention to the timbering of the roof and sides, and keeping a constant watch for any change or peculiarity which may appear in the overlying strata. The responsibility of securing his working place rests with the collier, subject, of course, to the direction of the overman or fireman, or other officials of the mine; and very considerable skill and knowledge of the local peculiarities of the seams worked are necessary to make a good timberman. For this reason it is very desirable that young men should be practically trained in this branch of their duty, and have the benefit of the experience of old and tried colliers who by years of service have become acquainted with the best ways of dealing with the dangers and difficulties which are daily and hourly presenting themselves.

The top and sides should be tested by sounding very frequently, this being almost the only way in which a dangerous place in the stratification can be detected, and a piece of ground, which to the eye would show no sign of danger, on being struck will give out a sound that at once tells an experienced ear that it is not firm, and precautions should then be taken against accident. The majority of cases brought under my notice were pure accidents, the coal or stone falling without any warning or showing any previous sign of weakness.

MR MARTIN, South Wales District.

The late Mr Wales animadverted annually in referring to these accidents, and expressed his opinion that the introduction of the North of England system of having deputies, or responsible persons for securing the places, instead of the miners themselves, would materially reduce the number.

Much may be said in favour of his views, but it is no easy matter to alter the custom of a large district, and, without doing so, I consider that the same effect would be attained if the management would constantly, and resolutely, require the miners to secure their places efficiently against the unseen and unexpected slips and breaks from which upwards of three-fourths of these accidents occur.

To attain this the management must be made definitely responsible in the first instance, and leave it for them to show that not only have materials been amply provided, but also that their use has been rigidly enforced.

RECENT RESEARCHES ON FRICTION AND THE ACTION OF LUBRICANTS.

By Prof. H. S. HELE SHAW.

TRANSACTIONS of the LIVERPOOL ENGINEERING SOCIETY. Oct. 1885.

THE author points out that the laws of friction, enunciated by Coulomb, which have been employed until quite recently by practical men for all cases, have only a very limited application, and that recent investigations indicate the existence of much more complex laws. The influence of change of velocity and change of temperature, of which Coulomb's law takes no account, are in reality very important factors.

In considering the effects of frictional resistance, he divides the subject as follows:—

1. The effect of the nature of substances in contact.
2. The variation of effect with variation of pressure.
3. The effect of change of relative velocity of the surface.
4. The effect of change of temperature.

1. *The effect of the nature of the substances in contact.*—From experiments made upon railway brakes, it was found that the co-efficient of friction was affected both by the material in the brake blocks and in the state of the weather. On dry rails, the co-efficient was generally about ·2; on wet or greasy rails, on which no sand was used, it had an average value for 300 experiments of ·18, but in one case was only ·15; in sand on wet rails, it was always about ·2; but when sand was used at starting, and was, therefore, not carried off by the wind of the rotating wheels, it was as much as ·35, or even ·4. The properties of lubricants are here discussed. For solid lubricants, graphite is considered the best; and for fluid lubricants, he recommends a judicious mixture of animal or vegetable, with good mineral oil, as the safest and most efficient, for all kinds of bearings. As there are reasons for attributing several recent conflagrations to the friction of the lubricant, the "fire test" he considers an important one. An oil should never be used for lubricating purposes which flashes at a point below 250° fah., some of the best mineral oils vapouring at 600° fah. The gumming and drying properties of oils may be simply tested by allowing samples to flow down an inclined plane. By means of testing machines (which have been devised for measuring the frictional resistance), it has been found that there are innumerable co-efficients for any one substance depending on the particular conditions of the experiment. One fact has been clearly demonstrated, viz., that the friction diminishes with the fluidity of the lubricant.

2. *The Variation of Effect with Pressure.*—The simple law which states that the resistance of friction varies directly as the pressure between the surfaces in contact is sufficiently true in the case of solid surfaces, but with lubricated surfaces the results obtained by varying the pressure are found extremely hard to bring under any definite law. Professor Thurston considers that the general result of experiments made by him on lubricated journals points to the friction, under ordinary conditions, varying inversely as the square root of the pressure. When perfect lubrication is effected, the resistance of friction, instead of increasing, as the hitherto received theory would assume, with heavy loads to a point at which great loss of work would take place together with the immense wear, only increases but slowly.

3. *The Variation in Effect Due to Velocity.*—The general results of recent experiments with low speeds shew that "the co-efficient of friction remained entirely unaffected by changes in the velocity so long as the surfaces were dry, but, when oil or water was present, the co-efficient of friction increased in a very marked manner as the velocity diminished.; this increase in the co-efficient of friction taking place under a limit of velocity of about 0·1 feet per second."

Experiments on railway brakes shew that at high velocities the friction of dry surfaces is very much reduced. One experimenter says that "the co-efficient of friction between the brake blocks and wheels varied inversely according to the speed of the train."

Another remarkable fact made evident by these experiments was that the co-efficient of friction was affected by the duration of the time of application of the brakes, the holding power of the brake blocks at all speeds being considerably less after some seconds of application.

4. *The Effect of Change of Temperature.*—Although much experimental work has been published as to the effect of different temperatures, the results are far from confirming each other. One investigator found with a bath of lard oil that, as the temperature rose from 60° F to 120° F, the friction diminished; while Professor Thurston, experimenting with sperm oil as the lubricant, found the friction increased with the temperature. The latest experimental results by this observer and others shew the laws which connect friction and temperature to be of a most complex nature. A. L.

RESEARCHES ON FIREDAMP.

ANNALES DES TRAVAUX PUBLICS DE BELGIQUE, Book 3, Vol. XLIV.

In 1884 the Belgian Minister of Public Works ordered the *Corps des Mines*, under M. Schorn, to make researches upon firedamp, according to the programme drawn out in the report of The Firedamp Commission. The first thing to be done was to ascertain the pressure of gas in the coal beds by means of boreholes. Our object, says M. Schorn, was not to verify the existence of considerable pressures, that being already demonstrated, but to obtain, by multiplied experiments, some more exact notion of the distribution of pressure in the different plies or zones of a bed; on the manner in which it may be modified by the working of the coal or preparation; and on the relation between the pressure and the disastrous phenomena known under the name of sudden outbursts of firedamp. The report deals with the results of these experiments only; as they have not yet been able to overtake the analysis of firedamp; which is considered requisite in spite of the conclusions arrived at in common by the English and French Commissions, that firedamp is essentially light carburetted hydrogen (CH_4).

While preparations for experiment were proceeding, the Engineers turned their attention to testing the foundation of a widespread belief held by mining men, that the faces of the working places recoil, or advance towards the waste in intervals of working. They found that a minute motion of this kind is generally in progress, amounting to from 2 to 2¾ inches a day; or, more commonly, in several days. A few well authenticated instances of this phenomenon are given. In one case the face advanced in a piece a distance of 6½ feet.

Some difficulty was experienced in making an air-tight stopping in the boreholes. At first clay pellets alone, or mixed with cotton waste, hemp, or small coal, were tried. While the stopping thus made was perfectly tight, it was generally found impossible to force the first clay ball further than 2 to 3 metres. The pressure registered by the manometer would, it was thought, under these circumstances probably be that of the gas in the vein at the end of the tamping and not at the end of the borehole. Mr Wood's device of alternate washers of indiarubber and wood on the manometer tube was found unsuitable in the friable seams, except for short holes of about 2 metres. A stopping of cement forced into the boreholes in a pasty state by hydraulic pressure could be made of unlimited length and quite tight; but the results of experiments seem to show that the length of the stopping is of little consequence, provided it prevents escape of gas, except in cases where the coal is much fissured.

Pressure appears to have no direct relation to the quantity of gas given off by a borehole before being closed; and the effect of the depth of a bore upon the pressure is equally uncertain. The results obtained do not agree with Mr Wood's generalization that pressure varies as the square root of the length of the bore; and the author expresses the opinion that pressure is so irregularly distributed as to be incapable of being expressed by any general law whatever. The experiments have led M. Schorn to explain this by the apparent small permeability of the coal, evidenced by the fact that boreholes within 3 metres (9 feet 10 inches) of each other maintained for days pressures differing by 10 to 15 atmospheres. At a depth of 670 metres (732 yards) a pressure was recorded, in one instance, rising in 24 hours to 30 atmospheres, and slowly increasing to 42¼ atmospheres at the end of 15 days. The gas was then allowed to escape freely for 9 days, and another trial of pressure made. It rapidly rose to 22 and finally to 35½ atmospheres. shewing the comparatively small effect of boreholes in draining a seam, and proving, if proof of this kind were required, that boring is no infallible safeguard against outbursts of firedamp. At the same time it is a useful and necessary precaution, inasmuch as many cases can be cited wherein, while ineffectual in preventing irruptions of gas and displacement of coal, the boreholes caused these phenomena to proceed so gradually as to allow the workmen time to escape. Mainly with a view to studying the mutual effect of boreholes and outbursts of firedamp, the face of a level drift was pierced to a depth of about six metres by two boreholes. Adjoining this a heading was

worked direct to the rise at an inclination of 40 degrees. The excavation was purposely conducted so as to induce, if possible, an outburst of gas. Four times did such a phenomenon manifest itself at the face of the heading within a distance of 14 metres above the level. Each of these outbursts was accompanied by detachment of coal from the face, and all, except the last, were preceded by a well marked fall of pressure in the boreholes. It would appear that pressure of gas is not the only factor in determining a sudden outburst; because trials of pressure made in a seam notorious for such phenomena shewed a pressure of only one-half to three-quarters of an atmosphere; while other beds giving enormous gas pressures are comparatively free from outbursts. One engineer who held the opinion that the gas pressure in any seam depended upon the hydrostatic head, and that pressure would be registered apart altogether from the emission of gas from the coal, was so far supported in his theory by experiment in a bed where the presence of any gas whatever could not be detected in boreholes, which, nevertheless, gave a pressure of nearly four atmospheres when the manometer was applied to them.

It was frequently noticed in the course of the experiments that a series of boreholes at one place would yield rather conflicting pressure registers. A fall of pressure in one or more would correspond with a rise in another; and this led M. Macquet to suggest that changes of pressure may be transmitted in waves, just like sound. While he does not press this kind of tentative hypothesis unduly, he marshals his facts in a way very favourable to it. Other explanations are, perhaps, scarcely less applicable; but the experiments are not sufficient to justify the setting forth of any hypothesis, much less to establish a law. The question appears to be almost where it was; the experiments serving principally to show the apparent lawlessness of the firedamp, and thereby proving how far we are from understanding how its behaviour is regulated. The author is impressed by this, as he concludes his report as follows:—It would be premature to attempt to draw any positive conclusion from the experiments carried out up till now. We have endeavoured before everything to gather materials for a study of the question of firedamp. The results obtained indicate that the pressure in the seams is subject to variations that ought to submit to a certain law, possibly dependent more or less directly upon movements of the strata produced by working out the mineral. We know nothing of this law as yet. By multiplying appropriate experiments to this end we may hope to acquire some knowledge of it; and it is possible that that knowledge may lead to the addition of useful precautions to those which are already employed against instantaneous outbursts of firedamp. J. H.

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CONCRETE WORK UNDER WATER.

By W. R. KINIPPLE.

The author gives the results of direct experiment and of his experience in certain large works, with the object of determining how Portland cement concrete may best be used in submarine structures, so as to secure soundness and reliability at moderate cost. Present methods, he holds, do not accomplish this. In his early experiments he noticed that partially set or plastic concrete appeared to possess the property of hardening into a solid mass under water, after being lowered into position in this plastic condition. Having hit upon this as a solution of the question, he adopted it regularly in his subsequent practice. Several cases are described in detail. The time required for the concrete to assume the requisite consistency varies with the constituents thereof, as well as with the atmospheric conditions. The best results were got by mixing with the smallest

possible amount of water, ramming the concrete into boxes, and depositing under water as soon as it acquired the consistency of stiff clay. There are other plans for dealing with special circumstances, but they depend upon the same principle. Several instances are given of an ingenious application of grouting with cement, for binding structures built of concrete blocks. In order to stop leakage in a graving dock at Greenock, the author had boreholes put down, from 1 to 2 feet apart, behind the dock wall, to a depth of several feet below the foundation. Down these boreholes neat Portland cement grout was poured. This permeated the fissures and joints, in some cases as much as 18 feet from the boreholes, and almost completely stopped the leak. In order to test the value of grout as a means of binding a subaqueous structure, the following experiment was made:—"At Aberdeen, a timber box, 6½ feet long, 1 foot wide, and 4 feet deep, was filled with round smooth stones of basalt and whinstone from 1 to 4 inches in diameter, and was lowered to the bottom of the tidal harbour in a depth of 18 feet at high water of spring tides. At high water a thick grout of four parts of Portland to 1 part Sheppy cement was poured down a wrought iron pipe 3½ inches in diameter, reaching 12 inches into the box, and rising a few feet above the water level, and this grout filled the interstices between the stones. After twelve days the box was lifted out of the water by means of the pipe, which had become firmly cemented into the concrete, and on removing the sides of the box the concrete was found to have a smooth surface, and to be perfectly solid throughout." Similar experiments were made elsewhere with equally satisfactory results, which prove, as far as they go, that the process may be usefully applied in many ways.

EFFECT OF TEMPERATURE ON THE STRENGTH OF RAILWAY AXLES.

By THOMAS ANDREWS.

Although a general impression prevails that the strength of iron is impaired by low temperatures, the exact change induced thereby has not yet been satisfactorily determined. Experiments have hitherto been mainly directed towards ascertaining the effect of cold upon the tensile strength of metals under a steady load, and the results have occasioned some conflict of opinion. It seems presently to be admitted that cold does not diminish the tensile strength of iron; but its effect on that metal under other strains, such as sudden transverse impact, has received less attention. Dr. Joule says—"Frost does not make either iron (cast or wrought) or steel brittle," but other experimenters have arrived at a different conclusion. Mr Andrews carried out his experiments upon axles of the ordinary size and manufacture. Few parts of machinery are subjected to such severe strains, combined with great variation of temperature. Apart from heating of journals, railway axles in certain parts of the world—Canada, for instance—are subject to a range of temperature between 100 deg. or upwards down to 30 deg. below zero fahrenheit. Of the breakages that occur in Canada and Russia, about 50 per cent. more happen in winter than in summer. How much of this is due to change in the iron induced by cold, and how much to greater rigidity of the permanent way during severe frost, must be determined by experiment. Mr Andrews' experiments were conducted upon a permanent testing plant, arranged to eliminate the latter factor, and were carried out under atmospheric conditions which excluded it entirely. The mode of experimentation was to subject the axle at the given temperature to repeated blows of a weight of one ton, falling freely from heights of 10 feet and 15 feet, on the centre of the axle supported upon bearings 3 feet 6 inches apart. Each axle was reheated or recooled to the requisite temperature, and turned half round in its bearings after each blow; and the testing was continued till rupture took place. The permanent deflection was measured after each descent of the weight, and the mean force of each concussion calculated from the observed deflection, and the known energy of the blow which produced it. For comparison, the total observed deflection and the sum of the mean force which each axle sustained before breaking are taken. Forty-two axles in all were destroyed. The

temperatures of experiment were 7 deg., 100 deg., 120 deg., and 212 deg., fahrenheit, and the results are given in tabular form. The conclusions deduced can only be considered tentative, so far as the exact relative strengths are concerned; but that low temperature is accompanied by diminished strength there is left no room for doubt. The averages for 7 deg. and 100 deg. compared give the ultimate resisting power at 43 per cent., and the flexibility 31 per cent., in favour of the higher temperature. Nothing conclusive as to the change which takes place in the iron can be deduced from the experiments, but they seem to indicate a more crystalline structure at the low temperature; because in the cold tests the deflection remained practically the same for each blow, whereas in the warm tests it steadily decreased from beginning to end of the experiment. The photographs of the broken metal also shew a distinctly more crystalline fracture at 7 deg. than at 100 deg. A striking feature of the tabulated results is the great variation in the cumulative mean force and deflection undergone before rupture of axles manufactured in exactly the same way and of the same materials. The three highest totals were under cold test, but in each case subsequent experiment on the halves of these axles resulted in favour of the higher temperature. In many cases very fine but detectable cracks were noticed on the surface of the axles before the rupturing blow. Steel axles appear to snap without previous warning of any kind.

ABSTRACTS OF FOREIGN PAPERS.

Blasting without Explosives.

As a substitute for explosives that may produce flame in the instant of explosion, or which require the intervention of flame to explode them, the author proposes to subject zinc oxide, collected from the flues of zinc retorts, to the action of sulphuric acid. Chemical action immediately begins with liberation of hydrogen and formation of sulphate of zinc. The cartridge consists of a glass cylinder 7 inches long and 1 inch in diameter, divided by a narrow neck in the tube into a zinc chamber aud a sulphuric acid chamber, in cubic capacity as one is to four. This narrow neck is stopped with a plug of cork or indiarubber. When about to be used the upper part of the cartridge is filled with the zinc dust, and a needle passed through it into contact with the stopper. The cartridge is placed in the shot-hole, which is tamped in the usual way. In the event of the rock being fissured, or very porous, the borehole must be lined with clay to prevent the escape of gas. The charge is exploded by a few sharp blows on the needle, which drives out the stopper and brings the acid into contact with the zinc. The evolution of hydrogen is not instantaneous, and appears to allow time for the miner to escape danger from the effects of the shot. A cartridge of 1 inch diameter and 7 inches long has a capacity of 5½ cubic inches, in round numbers, and the volume of hydrogen liberated will, at freezing, measure 119 cubic feet, or about 37,000 times the volume of the cartridge, giving a pressure in the borehole of 37,000 atmospheres. As the temperature is much above freezing, the volume of gas and the pressure will actually be greater. The pressure obtained from gunpowder is about 5000 atmospheres. The cost of a shot will be from 1½d to 2d, according to size of the charge. The question of risk arising from the liberation of so much inflammable gas in a working place of a mine is discussed by the author, who offers the opinion that, owing to the rapidity with which hydrogen diffuses in air, the power of inflaming is soon dissipated. As evidence of this, he says that if zinc dust be exposed to the action of sulphuric acid in an open dish, the gas given off cannot be lighted by a flame held to the edge of the dish, but must be applied to the bubbles of hydrogen to obtain detonation. This point requires to be settled by actual experiment on a full size scale.

Temperature Observations at the Lake Superior Mines.

We have here the record of some observations on the increase of temperature with the depth made in some copper mines on Lake Superior. The experiments are principally noteworthy for their exceptional results. The depths of the various mines are

between 600 and 2300 feet. The average increase of temperature is 1 deg. fahr. for each 100·8 feet in depth, and the rate varies from 1 deg. in 76·5 feet to 1 deg. in 122 feet. This great variation is not accounted for by the nature of the rocks, but is attributed (by the author) to the proximity of the large body of water of Lake Superior, at the low average temperature of 38·8 deg. fahr. The mines near the lake shew the lowest rate of increase, and those further away the highest. The mine giving 1 deg. for 76·5 feet is five miles distant from the waters of the lake. J. H.

Minutes of Proceedings of the INSTITUTION of CIVIL ENGINEERS.
Vol. LXXXVIII.

FRICTION CLUTCHES.

By WALTER BAGSHAW.

This paper is limited to a description of a dozen or thereby different friction clutches, designed for connecting and disconnecting machinery while in motion. It is found in using lubricated surfaces that the temperature affects the coefficient of friction very materially. At 120° Fah. the coefficient, using lard oil for lubricant, is only one third of the coefficient at 60°. Consequently the pressure required between the friction clutches must be raised for high temperatures. With dry surfaces experiments show a very small variation of coefficient with varying temperature. In a given case, at 50° Fah. the angle of repose of two surfaces was 10 degrees, and for the same surfaces at 620° Fah. it had risen to 11 degrees, shewing a very slight increase of coefficient at the higher temperature.

ABSTRACTS OF FOREIGN PAPERS.

Four of these deal with cement. First—**Testing of Portland Cement,** wherein is detailed the experiments carried out in a laboratory established solely for that purpose, by the French Government, in Paris. The immediate object appears to have been to test cements used in harbour works at Calais and Boulogne. About 12,000 briquettes were used in the experiments. From the results a specification was drawn out and the details thereof are given shortly in the abstract. Second—**Influence of Magnesia on Portland Cement** is the result of eight years' observation of works, both land and subaqueous. Nothing abnormal in the behaviour of the cement was ever observed while the works were under construction, but after a time, sometimes after several years, a change began which finally ended with complete destruction of the works. The volume of the cement slowly increased in a way apparently quite irresistible. Analysis of the cement then shewed about 43 per cent. of lime and 29 per cent. of magnesia. The cause of failure is laid upon the magnesia, which slowly became hydrated and expanded with results observed. Third—**A Practical Treatise on Portland Cement.** As bearing upon the above detailed cause of failure of cement, it is note-worthy that the author of this paper places the proportion of magnesia in good cement under 3 per cent. The characteristics of good cement are here set down, with the various tests applicable thereto, and the variations of quality admissible. Fourth—**The Effect of Peaty Impurities upon Cement Mortar.** In laying a floor with cement it was found to be quite soft after three months. The cement was suspected, but analysis proved it good. The sand had 4·3 per cent. of vegetable matter, evidently from peat. Tests with standard sand and the same cement resulted satisfactorily, but a three-part mixture of cement with suspected sand did not set. The failure is attributed to the humic acid combining with the lime; the compound thus formed surrounding the particles of mortar prevented setting.

From a French source comes a comparison between four methods of **transmitting**

power, viz.:—Electricity, Water Pressure, Compressed Air, and Ropes. The comparative results are tabulated at the cost in pence of transmission of 100 H.P. for certain distances as under.

System Employed.	330ft.	1,640ft.	3,280ft.	16,400ft.	32,810ft.	65,250ft.	Motor.
	d	*d*	*d*	*d*	*d*	*d*	
Electricity, ...	1·80	1·84	1·94	2·27	2·84	4·61	Steam.
Water Pressure, ..	2·27	2·36	2·61	4·03	5·79	9·57	Steam.
Compressed Air, ..	3·17	3·23	3·33	4·05	5·25	6·39	Steam.
Ropes, ...	1·26	1·49	1·58	2·88	4·99	12·68	Steam.
Electricity, ...	0·46	0·48	0·53	0.62	0·68	1·15	Hydraulic.
Water Pressure, ..	0·46	0·55	0·62	1.33	3·23	3·54	Hydraulic.
Compressed Air, ..	0·72	0·80	0·84	1·21	1·86	3·36	Hydraulic.
Ropes, ...	0·25	0·27	0·30	0·80	1·42	3·39	Hydraulic.

It is noteworthy that transmission of power by ropes is cheapest up to distances of over 3000 feet, and that for greater distances electricity takes first place.

Iron Framing for Pit Roads has been tried at Rochebelle Collieries under exceptional conditions that wood timbering could not be made to meet. Various forms of iron arched frames were tried but all failed. Finally circular frames made in halves and bolted together with fish plates were used successfully. Three standard sizes for the various classes of roads were made—5ft. 11in., 5ft. 3in., and 3ft. 11in. in diameter respectively. The cost of securing roadways with iron frames about one yard apart is stated at 12s 8d per yard. Tried alongside timber framing in same road the result is so far in favour of iron. The wood cost 16s 9d per yard for same period, with 2s 7d per annum to add for repair, against the cost of 12s 8d for iron, without anything for repair for the period of trial. Out of 2000 iron frames in use not more than 2 per cent. have been broken. The use of iron has been further extended to packing and sheeting in form of iron lathes of various sizes, but results are not yet ascertained.

Under heading, **Self-Acting Stops for Inclined Planes,** there is described a Belgian contrivance for stopping runaway hutches. It consists of a wooden bar 4 in. in diameter slung from a strand of old winding rope fixed on a set of timbers, and hanging at such a height as to catch descending hutches, unless raised by a hand line provided for the purpose. When in position both ends rest against the timbering, so as to prevent it swinging clear of the descending trains, while it is easily pushed aside by the upgoing ones. The whole apparatus was fixed for about 2s, and had worked for seven months without any trouble; but nothing is said as to its efficiency, which appears a somewhat doubtful point.

It is interesting to have a comparison of the methods of our forefathers with the processes of our own day. This is supplied by a paper on **The Action of Powder, Dynamite, and Fire-Setting at Kongsberg,** Two silver mines in Norway are worked—the one in very hard hornblende schist, and the other in soft mica schist. In the softer rock powder and dynamite cost about the same, but in the harder rock dynamite has much the best of it. Fire-setting is still used, and the following is the comparative cost of driving a metre of level with the various methods:—

	Fire-setting.	Powder.
Kongen Mine (mica schist), ...	£3 13 9½	£4 4 7½
Gottes Hülfe Mine (hornblende schist), ...	3 7 9½	5 6 0

As compared with dynamite, but at a time ten years after the foregoing, the costs were:—

	Fire-setting.	Dynamite.
Kongen Mine, ...	£4 19 7	£3 19 8½
Gottes Hülfe Mine, ...	3 18 8½	4 16 5

J. H.

BOILER EXPLOSIONS.

By Mr Samuel Boswell.

TRANSACTIONS of the MANCHESTER ASSOCIATION OF ENGINEERS.
Oct. 1886.

In this paper the author treats his subject from different standpoints, viz.:—Causes, types of boilers, and remedies, and results of inquiries by Board of Trade and Coroners' Juries, and finds from his experience that the principal causes from which boilers explode are (1st) Defective condition; (2nd) Malconstruction; (3rd) Mismanagement. Defective condition embraces corrosion in various forms due to chemical action, fractures due to mechanical action, and channeling due to a combination of mechanical and chemical actions. Outside corrosion he finds is more dangerous generally than internal corrosion. The chemical action set up is due to the acids found in the feed water, or introduced through the feed-heater if refuse from the cylinder is allowed to enter. This action can be counteracted by neutralising agents, and is very difficult to detect, as the plates are so evenly wasted over all the exposed surface that one would think the plates had just left the rolling mill. A case is referred to where the boiler plates were reduced in this way from 7-16ths to 1-16th of an inch, and it was only from the seams and rivets that it could be detected corrosion had taken place. This peculiar corrosion is generally found to be most severe on heat-giving surfaces, such as bottoms of externally fired boilers, furnaces of internally fired boilers; and is principally caused by the use of a peculiar class of mine water and others of a peaty nature, which contain free oxygen and in which no sediment is to be seen, which readily attacks the plates. As a preventive against this a few days feed from water charged with calcium sulphate is recommended to give a scale coating, which will last for a time and can be renewed as required. Corrosion is also to be found in pittings and in scattered patches—it being found at times deepest on the coldest plates, and in other cases is found to affect mostly the heat-giving surfaces. It may also be seen affecting the crowns of flues and furnaces, also the under side of flues, &c., &c. All those cases may be seen in one district using the same water. There is another form of internal corrosion which is often met with, and it is that which is to be found under incrustations, which is not of a very serious nature, except when found in the form of longitudinal channeling. In these cases deep pittings are found under the incrustation, and on removal a blue or black substance resembling oxide of iron is seen. External corrosion the author considers to be a worse enemy than that which takes place internally, and is mainly due to leakage, dampness in the flues, and other causes, which, being covered by the brickwork surrounding the boiler, makes the defects difficult to detect. The dampness in the flues he considers due to natural dampness in foundations, and flues being lower than the surrounding surface level, flues not being drained, and many other causes. Fractions due to mechanical action may be found in many parts, according to the form of boiler, and are often found in the overlap of ring seams in furnaces and in the bottom of boilers externally fired. So long as those fractures are from rivet hole to edge of overlap they need not be looked upon as dangerous, but immediately they pass from the rivet hole towards the centre of the plate or from hole to hole they should be at once seen to. The most dangerous fractures that can exist are those running longitudinally along the shell, as they readily open out and yield to

internal pressure. Fractures are often caused by over-heating and sudden contraction, when the plates are prevented from shrinking to their normal size by the expansion of other parts of the boiler. The class of boiler most subject to this dangerous defect is the externally fired cylindrical boiler, particularly when it is hung on side brackets and when sedimentary water is used. At the time when the fires are burning brightly the shell bottom and sides are at their fullest limit of expansion, and the boiler having a tendency to rise at the ends, throwing all the weight on the middle brackets, and thereby causing leakage; and, again, immediately on the furnace door being opened the order of things is reversed, and before the sides have time to adjust themselves the plates on the bottom will fracture at the rivet holes. The same defect is brought about by blowing a boiler off under steam and filling it with cold water. This is often found to fracture the seams, the damage not being found out until the boiler is again working. This, the author explains, is the cause of so many explosions immediately after cleaning. Grooving and channeling, from which so many explosions have their source, are caused by a combined mechanical and chemical action, and are to be found at all parts which offer a resistance to the uniform movement caused by contraction and expansion. He further goes on to take note of the construction of various kinds of boilers in use, and the causes of the various explosions which have taken place during the past few years.

A. L.

EXCAVATION AND EMBANKMENT BY WATER POWER.

E. B. DORSEY.

TRANSACTIONS of the AMERICAN SOCIETY of CIVIL ENGINEERS. May, 1886.

MR DORSEY describes in considerable detail a method which has been developed in California for making cheaply large excavations and embankments by means of discharging water under a vertical head of from 100 to 300 feet against the bank to be excavated. The momentum of the water cuts into the bank, the material from which is conveyed to the place where the embankment is being constructed. Should the point of discharge be some water course or river, it soon becomes dammed by a perfectly water-tight dam. The amount of work accomplished by this means he states to average 3½ cubic yards daily per miner's inch—which in California is taken as the unit of measurement of water, and is equal to 17,000 gallons (U.S.) in 24 hours. The work, of course, varies with the kind of material, the limit being from 1½ to 9 cubic yards daily. The average cost per cubic yard, assuming the duration of the work for one year, and the water pumped 200 feet high, he states at 7½d per cubic yard, thus—

Water, - - - - - - - - -	$0·045
Plant, - - - - - - - - -	.06
All other Expenses, - - - - -	·04
	0·145, or 7½d per cub. yd.

Assuming the duration of the work for four years, it would be 5d per cubic yard. The author points out, that to obviate the necessity of pumping, in some localities a few cheap dams and ditches could be constructed at an elevation sufficient to give the required head of water.

The reasons for its adoption he states as follows:—(1) It will be much cheaper than the earth dam constructed in the usual manner; at least one-half where the material is good, and where the material is bad the difference would be still greater, probably one-fourth. (2) It will permit the construction of earth dams where the material is so bad that the ordinary dam could not be constructed. (3) Owing to cheapness the dam could be much stronger. (4) The dam will not settle or crack; it is as compact and as solid at the beginning as it can be made. (5) As it will not settle or crack, it is ready for use as soon as it is finished.

A. L.

Minutes of Proceedings of the INSTITUTION of CIVIL ENGINEERS. Vol. 86, 1885-86. Part IV.

THE MERSEY RAILWAY.

By FRANCIS FOX, Westminster M. Inst., C.E.

THIS important undertaking was incorporated by Act of Parliament in 1866, with the object of effecting a junction between the railway systems on each side of the river Mersey, by means of a tunnel driven under the river, and thus connecting the City of Liverpool on the Lancashire side, and the town of Birkenhead on the Cheshire side of the estuary. Borings having shown that the New Red Sandstone extended generally across the river, the preliminary works were begun in December, 1879, by Major Isaac undertaking the risk of driving an experimental heading to prove the continuity of the rock, and its freedom from fissures. By May, 1881, this work had advanced sufficiently to justify the commencement of the permanent works, which were contracted for in August, 1881, and vigorously proceeded with by day and night, until completed and opened for traffic on 1st February, 1886.

Shafts and Pumping Machinery.

The permanent works were commenced by sinking two pumping shafts, one at Liverpool, 15 feet in diameter and 170 feet in depth, and one at Birkenhead, 17½ feet in diameter and of similar depth. The distance between the quay walls on the two banks of the estuary, at the points where the tunnel passes, is 1320 yards, and the distance between the pumping shafts 1770 yards. The Liverpool shaft was lined with cast-iron tubbing, except those portions which were in solid rock and not yielding water. At the bottom of the shafts, standage heads were driven, each having a capacity of 80,000 gallons. The pumping machinery at Liverpool consists of a pair of pumps, 20 inches in diameter by 6 feet stroke, connected by means of quadrants with a compound engine by Messrs Hathorn, Davey & Co., of Leeds; the high and low pressure cylinders having diameters of 20 and 35 inches respectively with a stroke of 6 feet, and fitted with differential valve gear; also, a pair of pumps, 30 inches in diameter, driven by a compound engine having high and low pressure cylinders of 33 and 60 inches diameter respectively, and a stroke of 10 feet; and lastly, one pump of 40 inches diameter, with a length of stroke of 15 feet, driven directly by an overhanging beam compound engine with high and low pressure cylinders of 36 and 55 inches diameter respectively, both cylinders being double-acting. This engine is of the type introduced by Messrs Barclay & Son, Kilmarnock, and was adopted on account of its small liability to accident, and economy of floor space. The pumping machinery at Birkenhead is similar to that above described, with the addition of a second 40 inch pump with a 15 feet stroke. Arrangements are made by which the water from both sides of the river can be collected at either shaft, thus giving ample facilities for any repairs to the engines or pumps. The capacity of the pumps at ordinary speed is 18,800 gallons per minute, and the quantity of water to be permanently dealt with is from 7000 to 8000 gallons per minute.

Drainage Headings.

From each shaft the drainage heading was driven under the river towards the centre, with rising gradients of 1 in 500 and 1 in 900. These headings were at first driven by hand; but on February 15th, 1883, preparations were begun at the Birkenhead end for putting in a Beaumont boring machine, which was started on 26th March, 1883, and by the 17th January, 1884, the Birkenhead heading had been driven 696 yards, and met the Liverpool heading, which had been entirely driven by hand. This gave an average weekly progress of seventeen yards with the machine, and its greatest rate of progress in any one week in this heading was thirty-four yards. The machine was afterwards slightly modified, and the cutters better adapted for working the rock, and during January, 1885, the rate of progress was fifty-four yards per week through similar rock in a loop heading. In the softer rock met with in the Liverpool ventilating heading, a speed of sixty-five yards per week was attained. The speed of driving by hand varied

from ten to thirteen yards per week, giving a nine feet by eight feet heading—a size large enough for working double roads. The circular heading, seven feet four inches in diameter, made by the Beaumont machine, required to be both heightened and widened before it could be utilised for the work. The rock being mostly strong and solid, only small portions of the headings were lined, and at one place recourse was had to "plank tubbing," which answered its purpose admirably. It was somewhat remarkable that the wettest portions of the driftway were those under the land, and that as soon as the work was proceeding under the river, the yield of water in proportion to the area exposed, diminished. This may be accounted for by the clay and sand in the river having filled up any fissures in the rock. For various reasons, the setting out of these headings was a work of considerable difficulty, but it was accomplished with great precision by the joint efforts of the resident and the contractor's engineers, the result being that when the headings met at 1115 yards from the Birkenhead working shaft, and 639 yards from that of Liverpool, there was an error of only one inch at meeting and two-and-a-half inches maximum error at the centre from the true line as afterwards ranged through. The levelling was an easier process, the ordnance levels on each side of the river being accepted as correct. The levels were transferred down the shafts by carefully checked steel tapes, and the final result was when the headings met at a point which had been fixed as being 129·05 feet above datum as levelled from Birkenhead, was found to be 129·04 feet above datum as levelled from Liverpool; this affords good proof of the general accuracy of the ordnance levels. As long as the excavations were carried on by hand and blasting used—(bore-holes were kept in advance of the face, but when the Beaumont machine came into use these were considered as no longer necessary—safety or flood gates were provided, but at the request of the workmen they were removed, nor did any occasion ever arise for their being made use of). In the improbable event of all the pumps—six distinct sets—stopping at the same time, the standage capacity of the drainage heading is sufficient to prevent the water rising so high as the rails in the tunnel for a period of five hours, thus giving ample time for any ordinary repairs.

The River Tunnel.

The tunnel is 26 feet in width, and where in rock is lined and inverted with brickwork in cement 2ft. 3in. in thickness, the two inner rings with headers being of brindle brick. It is 19 feet high from the rail to the intrados, or 23 feet from the invert to the intrados, and it is provided with recesses for the platelayers on each side at distances of 45 yards. Near the Liverpool side there is a depression in the rock, supposed to be the ancient bed of the river. The tunnel at this point has a total cover of 70 feet, but for a length of 66 yards the crown is from 3 to 6 feet above the level of the sandstone rock, and passes through a thin layer of red clay and sand and covered with strong brown clay. The tunnel was put in here by well timbered lengths of 9 feet only, and the brickwork in the crown was thickened to 3 feet. No difficulty was otherwise experienced. The remainder of the tunnel was proved to be in rock by a series of bores being put upwards to a height in every case of 15 feet above the crown of the tunnel. The minimum amount of cover between the extrados of the arch and the bed of the river is about 30 feet, and the depth of the water at high tide is 100 feet. The tunnelling was carried out by means of a heading driven through with all speed and numerous "break-ups," so that at one time work was proceeding at twenty-four faces, the whole being well drained by the arrangements previously described. Additional shafts were sunk both at Birkenhead and Liverpool for winding purposes, to which the rock was brought by inclined planes worked by steam engines. These shafts were closed on the completion of the works.

Ventilation.

The ventilation of the tunnel and stations was the subject of much consideration, but eventually the principle adopted was that the fresh air should enter at each station and split each way into the tunnel. By this means, the atmosphere on the platforms is always maintained in a state of purity. The air has then to travel towards a point midway be-

tween the stations, whence it has to be extracted from the tunnel by means of fans through the ventilating heading. This heading was cut by the Beaumont boring machine, and is circular in form, 7 feet 4 inches in diameter, and almost as smooth and true as a gun barrel, and about 2250 yards long. It is connected with the tunnel by throughers with sliding door regulators, so that the air can be extracted from any point desired.

It was calculated that it would require 232,000 cubic feet of fresh air per minute to keep the atmosphere in the tunnel reasonably pure, and for this purpose there are four fans provided—two are 40 feet diameter by 12 feet wide, and two 30 feet by 10 feet, one of each size being erected at Liverpool and Birkenhead respectively. The engines for working the fans are all similar in design and construction, each fan having a compound tandem condensing engine, with a horizontal condenser, coupled direct to the fan shaft. There is also a simple high pressure stand-by engine, which can be connected to the fan in a short time. For the 40 feet fans, the high and low pressure cylinders of the compound engines are 20 and 33 inches diameter respectively, with a 2½-feet stroke; the stand-by engines have cylinders 33 inches diameter. The engines of the 30 feet fans have, for the compound type, cylinders of 15 and 24 inches, with a 2-feet stroke; the stand-by engines have cylinders 34 inches diameter. For the purposes of ventilation, the tunnel is divided into four sections, one fan being allotted to each; but two fans at Liverpool and one at Birkenhead can at any moment, through the medium of doors in the air headings and passages, be made to do each other's duty as well as their own, and by this means a complete stoppage of the ventilation of the tunnel is rendered impossible in ordinary circumstances. The 40 feet fans ventilate the portion of the tunnel lying directly under the river, and the 30 feet fans the approaches thereto. The fresh air enters through the respective stations as well as the entrances to the tunnel, but to relieve the stations from strong draughts, the two pumping shafts are also used for the admission of fresh air, the quantity of which can be regulated. The total yield of the four fans amounts to 580,000 cubic feet per minute, or about one-seventh part of the total cubic capacity of the tunnel. There is a considerable margin between this duty and their maximum exhausting capacity. The fans and engines were made and erected by Messrs Walker Bros., Wigan.

The permanent way, signals and telegraph, locomotives and rolling stock have been specially designed to suit the exceptional requirements of the works, and are constructed with all the most recent improvements. Major-General Hutchinson, the Inspector of the Board of Trade, sums up his report on this railway as follows:—"In conclusion, I think it is only just to remark that great credit appears to be due to the engineers and contractors who have so ably carried out, and brought to so satisfactory a conclusion, this great and important work." J. P.

Minutes of Proceedings of the INSTITUTION of CIVIL ENGINEERS, Vol. XC., 1886-87, Part IV.

ACCIDENTS IN MINES.—Part I.

By Sir FREDERICK ABEL.

The author was a member of the Royal Commission on Accidents in Mines, whose final report was issued in March, 1886. This paper is pretty much an epitome of the Commissioners' report, and therefore traverses substantially the same ground gone over by Mr Gemmell in his paper on that report (Vol. VIII., pp. 75-126).

The course of mining legislation since 1835 is shortly reviewed, and attention is directed to the improvement in the working and management of mines since, due to that legislation, and to the appointment of inspectors since 1850. Figures are given to show that legislation has proved beneficial in reducing the proportion of accidents to the number of persons employed, and in improving the condition of miners generally. In 1850, 50 million tons of coal were put out by 200,000 persons, at a sacrifice of 1000

lives. In 1877, 134 million tons were put out by double the number of workmen, with a loss of life of 1200. Still attention was directed to the lamentable loss of life, not only from explosions, but also from the less obvious but more deadly cause of falls. The reports of the mines' inspectors for the eleven years, from 1875 to 1885, shew the deaths due to explosions, to falls, and to miscellaneous causes, to have been as follows :—

Total deaths from all causes, ..	12,315
Deaths from explosions, ...	2,903 = 23·57%
Deaths from falls, ...	5,021 = 40·77%
Deaths from other causes, ..	4,391 = 35·66%

In comparing the inspectors' reports since 1851, it is seen that miscellaneous accidents do not show the same proportion of decrease as others. This may be due to some extent to the great extension of mechanical haulage, by which risk to life from the more rapid mode of conveyance is increased.

In the matter of shaft accidents, great improvement has been effected. The number of persons employed to each fatal accident, was :—

From 1850 to 1860, ...	1161
From 1860 to 1870, ...	2121
From 1870 to 1880, ...	3557
From 1880 to 1883, ...	4713

An instance is given of a South Wales colliery where, during twenty years, nearly six million persons were raised and lowered without a single shaft accident.

Safety cages and devices for arresting the cage in the shaft in the event of a breakage of the winding rope, have not been so certain and reliable in action as to merit general adoption; and safety hooks, to prevent the cage falling in the event of an over-wind, have met with only qualified approval. Steam brakes, which are more reliable, are being introduced.

The inspectors' reports of recent years shew that deaths from falls bear a larger proportion to the total deaths than they did thirty years ago, although there has been a decided reduction in the average death-rate from this cause per 1000 persons employed. The conditions affecting the safety of roofs and sides are so various, that the prescription of definite rules to save against falls is impracticable. Improvements are being made in the introduction, to a small extent, of iron and steel instead of timber for props. In some Welsh mines wrought-iron frames for main roads are used, where great pressure has to be resisted. Careful and intelligent inspection, and the continued devotion of skilled labour to the liberal providing and maintaining of reliable supports, even where their necessity may seem open to question, constitute, in the view of the author, the best safeguards against this form of accident. The extension of mechanical means for getting coal may lessen risk from falls, as the ratio of work done, to the time spent by the men close to the working face, will increase. As a protection against accidents from falls, good light is of importance; and the light furnished by the safety lamps hitherto most generally employed, has been utterly inadequate.

Some of the phenomena connected with the issue of fire-damp are then referred to. Its chemical composition varies at different places and at different times in the same place. A freshly-exposed face emits gas which consists almost entirely of pure light carburetted hydrogen; and as the process of draining goes on, the gas is found to contain increasing proportions of carbonic acid and nitrogen. The state of high tension in which gas occurs in some coals is frequently the occasion of accident through the bursting of the coal from the working face, or the discharge of volumes of gas with which no ventilation can cope. Experiments have been made by Mr Lindsay Wood, and also by the Royal Commission on Accidents in Mines, by means of boreholes in a working face of coal, and pressures of 206, 300, and as high as 461 lbs. per square inch have been recorded; but the results have been so various, even in the same seam and in apparently similar conditions, that there is need for further investigation and experiment in this direction.

It has hitherto been considered that fire-damp to be explosive should have 7 parts by volume to 100 parts of air; but the Commission found that the flame could be transmitted by a mixture containing little more than 4 per cent. of fire-damp. It was experimentally demonstrated that the facility with which flame travels through a mixture of air, with a comparatively small proportion of marsh gas or pure fire-damp, is dependent upon the diameter of the chamber containing it. Thus, a mixture that would not burn in a tube 1¾ inches in diameter, burned in a tube 3 inches in diameter. A violent explosion was produced in a Clanny lamp in a current containing 6 per cent. of fire-damp, travelling through a channel 13¼ inches by 10 inches. German experimenters have confirmed these observations. As to the proportion of gas in air which can be detected by means of a safety lamp, Mr William Galloway, in careful experiments, could just detect 2 per cent. by volume of pure fire-damp in air—an exceedingly faint cap, ¼ inch high, being observed by him on a most carefully adjusted flame of a Clanny lamp. It has been found that the readiness with which fire-damp can be detected on the flame of the safety lamp depends to some extent on the kind of oil used. Benzene, or a mixture of benzene and rape oil, is more sensitive than rape oil alone. Continental experimenters were led to prefer the Mueseler to the Davy for detecting gas. It follows then that air with double the minimum amount of fire-damp that can be detected by a safety lamp in the hands of an expert observer is explosive. This points to the need of a more delicate detector of fire-damp than has been in use hitherto.

Of the several fire-damp indicators—some of which evince much ingenuity in their construction—Liveing's appears to be the only one yet brought forward that promises to adapt itself to working conditions.

The connection between changes of the barometer and the escape of gas from the face or from goaves into the mine ways is not of much practical consequence in the majority of British mines, which are now provided with ventilation amply sufficient to cope effectually with any such possible variations in the conditions of the air in the workings. The popular belief in the coincidence of explosions of fire-damp with a low state of the barometer has been found to be fallacious. The author's conclusions in respect to precautions against accident from outbursts are as follows:—"With respect to the sudden invasion of mine workings by large volumes of fire-damp bursting forth under great pressure, the most that can be hoped for, with existing knowledge, is some reduction in the frequency of such occurrences; and the Royal Commissioners lay stress upon their convictions that the only present safeguards against such serious consequences as may result from their occurrence are to be found in the provision of ventilation ample to cope with exceptional demands upon its powers; in constant watchfulness, combined with strict discipline; in the provision of lamps which can be relied upon as perfectly safe where explosive gas mixtures travel at high velocities; and in abstention from the use of powder or of other explosives, except under conditions and precautions which the experiments of the Commissioners have enabled them to indicate definitely as calculated to insure safety.

The desirability of placing the ventilating fan some distance from the upcast shaft, as a precaution against damage from explosion, is advocated: and auxiliary ventilating appliances, such as those of Körting, have been found useful in the event of accidents. Great improvement has been effected by the dividing of the ventilating current into splits, and the mines into separate ventilating districts—thereby tending to limit the disastrous effects of an explosion occurring in any one district.

In some of the explosions of recent years attention has been drawn to other elements of danger from explosion than fire-damp; but the consideration of these and of the subject of safety lamps the author reserves for another paper. The paper under review is an interesting one, and places before the reader in a popular manner the outstanding features of an important subject.

G

ON THE MANUFACTURE OF SALT NEAR MIDDLESBROUGH.

By SIR LOWTHIAN BELL.

In this paper a description is given of the circumstances which led to the discovery of the extensive beds of rock-salt at Middlesbrough; the mode of raising the salt to the surface by solution, the boring and pumping arrangements being figured and described; and the details of manufacture of the various kinds of salt, domestic and otherwise, as well as of the other products arising from the process.

In the SELECTED PAPERS there is an account of

The Sinking of Two Pits at Gneisenau Colliery, near Dortmund.—

The costs of sinking by the Kind-Chaduron system and the ordinary mode of sinking and pumping are compared, the result being a saving in the former of nearly a half. The strata in parts of the sinking were heavily watered. One feature of importance in this undertaking was the extensive use of concrete for shaft-walling.

The ABSTRACTS of FOREIGN PAPERS contain short notes on the following subjects:—

Boring by Hydraulic Machinery in Westphalia.—In the driving of a mine 2½ metres broad and 2 metres high, in sandy shales and sandstone, over a period of four months, the average speed by hand was 0·43 metre per day, at a cost of £3 1s 6d; while with Brandt's hydraulic machines the speed was 2·08 metres, at a cost of £4 19s 2d per metre. In coal, over eight months, the speed by hand was 1·13 metre per day, at a cost of £1 16s 2d; and by the machine, 4·027 metres, at a cost of £2 11s 7d per metre.

On the Stauss System of Colliery Cage Props.—The inventor claims economy of time, economy of steam, less tear and wear of ropes, less tear and wear of the engine, and the possibility of employing smaller engines.

On Longwall Working in Successive Stages with Single Incline Roads worked by Small Hauling Engines.—It is argued that in the working of thin seams, where much dirt has to be turned over, it is less expensive to work with single incline roads, using small hydraulic engines at the foot of them, for haulage, than double self-acting inclines.

Wire-Rope Haulage at the Grand Ducal Mines, at Klippberg, in Teschen.—A ropeway is described, 1769 yards in length, with a fall of 914·4 feet—the rope, 1·22 inch diameter, being capable of conveying 10 tons of ore per hour.

An Underground Ventilator at the Shamrock Colliery in Westphalia.—The fitting up of the fan (Geisler's modification of Rittinger's construction) is described, and results of working given. The first cost was £3400, including excavations underground, and the working cost was found to be about the same as for furnace ventilation.

Electric Railways in Mines in Germany.—The installations at three collieries are shortly described, and the cost of the electrical system with others compared as follows, all being reduced to a tonnage of 400 tons over a distance of 2200 yards:—

Self-acting Chain,	0·45	pence per ton-mile.
Electrical Locomotive,	0·88	,, ,,
Endless Chain,	1·31 to 1·46	,, ,,
Various Systems of Traction by Cables,	1·66 to 2·00	,, ,,
Horses,	3·24	,, ,,

J. B.

Transactions of the NORTH of ENGLAND INSTITUTE of MINING and MECHANICAL ENGINEERS. Vol. XXXVI.

ON THE SYSTEM OF WORKING IRONSTONE AT LUMPSEY MINES BY HYDRAULIC DRILLS.

By A. L. STEVENSON.

AT this place, advantage is taken of feeders of water, amounting to 1700 gallons per minute, which were tubbed back in the shaft, for the purpose of working the Cleveland ironstone by hydraulic rotary drilling machines, actuated by turbines. A range of 6in. pipes is connected with the tubbing, and the pressure got at the shaft bottom is 215 lbs. per square inch. The machine is carried on a bogie, the break of which is applied by a hand wheel and screw, and another hand wheel and screw, by means of bevel gearing connected to one of the axles, enables the position of the machine to be adjusted on the rails. On the bogie is carried a strong hollow cylindrical upright, which can be turned about its axis by a worm wheel driven by a ratchet brace. On a hollow horizontal axis projecting from the top of the upright there turns a hollow semicircular worm wheel, also actuated by a screw and ratchet brace. Through the top part of this hollow wheel passes a malleable iron tube to which a rotary motion can be given. On the end of this tube the turbine is fitted, to which the pressure water is led up the central upright, through the hollow sector, and along the malleable tube. The axle of the turbine drives a screwed boring bar and the boring drill by bevel gearing, and the bar and drill have a motion around the axis of the turbine, and can be clamped in any position. The paper is illustrated by three drawings, which make the details clear. From the number of movements in the machine, the drill can be set in almost any position. It pierces the ironstone at the rate of 2 feet 5 inches per minute, and consumes, while running, 66½ gallons of water in the same time. At a trial, it took 79 minutes to drill 17 holes measuring in all 76½ feet, or nearly one foot per minute, including the time spent in setting the machine and changing the drills. It is worked by one man and an assistant, and following them is a shot firer, and the stone is broken up and filled by a gang of labourers. In a shift of eight hours, about 55 holes are drilled, producing 125 to 152 tons, costing, however, for powder 2d·66 per ton, against 1d·83 when the work is done by hand.

A FIREDAMP INDICATOR.

By Sir WILLIAM THOMAS LEWIS and A. H. MAURICE.

This indicator is an improved form of the original instrument of Maurice. Firedamp is decomposed by a platinum wire heated to redness by the current from a battery, and the resulting contraction, as measured by an air gauge, indicates the percentage of gas present. The bulb of the gauge is placed within the combustion chamber to neutralize the effect of the heat due to combustion, and the contraction of the gases alone affects the reading. It takes a considerable time to burn out all the gas, but it is found by experiment that it is consumed at a constant and uniform rate whatever the percentage present and whatever the battery power applied, and that in all cases one-half of it is consumed in fourteen seconds. Founding on this, a current is passed for fourteen seconds, and the instrument is so graduated as to indicate the full percentage of gas in the air. In this way a chief objection to this form of instrument is removed, viz., the length of time needed to make a test.

ARCHER & ROBSON'S PATENT "SPRAYER" FOR LAYING DUST IN MINES.

By T. O. ROBSON.

A sketch of this apparatus is given on page 121 Vol. IX. of the Transactions. It is in use at Redheugh Colliery where it is found that the contents of the tub—100 gallons—is sufficient to damp the dust on 1700 yards of roadway. The tub is attached to the train

of hutches and travels at the rate of four miles per hour, the water being thrown to a height of six feet from the bristles of the brush. It was, however, admitted in the discussion by Mr Robson that the machine would require to pass three or four times over the roadway in order to thoroughly saturate the dust.

ELECTRIC SAFETY LAMP WITH PRIMARY SINGLE LIQUID BATTERY.

By S. B. COXON.

In this lamp the Schanschieff battery is employed. The exciting solution is a preparation of a salt of mercury ($Hg_2 SO_4 + Hg SO_4 + 3 H_2O$), which is perfectly transparent. Of this liquid 3ozs. are required per candle per hour. The lamp when charged to give a light of one candle for eight hours weighs 3lbs. 4½ozs. The battery is stated to yield a perfectly steady current and to give off neither fumes nor smell. It has three cells, and the carbons and zincs project about half way down them, the existing liquid occupying the other half when the lamp is out of action. The current is passed by bringing the exciting liquid into contact with the plates by simply turning the lamp over and carrying it by what was before the bottom handle—the lamp being out or alight according as it is carried by the one handle or the other.

ON "SECURITE," A NEW BLASTING COMPOUND.

By S. B. COXON.

Securite is a German invention, and is manufactured from the bye-products of coke ovens and gas works. Its advantages are summarised in the paper as follows:—

1.—Its preparation, storing, and manipulation are perfectly safe.
2.—It cannot be exploded by ordinary concussions or blows, nor by a burning or glowing body.
3.—Its use is perfectly safe in fire-damp and air charged with coal-dust.
4.—It breaks down the coal in a similar manner to ordinary powder.
5.—When exploded it yields harmless gases, so that men can work in enclosed spaces immediately after an explosion has taken place therein.

Herr Margraf, mining inspector, reports favourably in regard to its employment in mines containing fire-damp and coal-dust. J. G.

AMERICAN SOCIETY of CIVIL ENGINEERS. Trans., Vol. XVI., March, 1887.

THE EFFECT OF FREEZING ON CEMENT MORTARS.

By ALFRED NOBLE, M.Am., Soc. C.E.

IN this paper the author gives his experiences of the use of mortar made with both natural and Portland cements, the latter being by far the most durable, especially in frost. He finds that the mixture of salt with the cement during very cold weather has beneficial results, and gives tables showing the increase in tensile strength. The salt is added to the water used, forming lime, and the quantity varies in the author's experiments from ·3 to 2·4 per cent. on the weight of the cement used. In the discussion the author's experience was verified by several speakers, who stated that it was their usual practice to add salt in the form of brine when building in the winter with either natural or Portland cements. According to Mr J. R. Cross, the preparation of that used at the Woolwich Arsenal Works was: "Dissolve 1lb. of rock salt in 18 gallons of water when the temperature is at 32° f., and add 3oz. of salt for every 8° below that temperature." W. T.

Transactions of MANCHESTER GEOLOGICAL SOCIETY. Vol. XIX., Part X.

UTILISATION OF MARSH OR NATURAL GAS.

MR STIRRUP called the attention of members to the recent discoveries of natural gas in the States of Indiana and Ohio, U.S. The first bore struck gas on 5th March, 1886, and from that date until May 8th, 1887, no less than 118 companies have been formed to make use of the discovery, and many more have since been added to the list. Free land, free water, free gas will be granted to large mills and factories that may be established. Whether the prospective advantages thus proclaimed will be utilised is as yet uncertain; but if they are, even in a moderate degree, it will puzzle the already over-weighted British producer to maintain his own when his American cousin is offered fuel for lighting and heating free of cost. Mr Stirrup concludes with the following cheerless remark:—"The inducement thus offered to the capitalist is very great, and it seems to me that we on this side of the Atlantic may have to succumb to the greater natural advantages which the United States offer, as we have nothing to enable us to compete with them in this respect." W. T.

Proceedings of the SOUTH WALES INSTITUTE of ENGINEERS. Vol. XV.

THE WATERING OR DAMPING OF DUSTY MINES.

IN a discussion on this subject, some experience is given of the means adopted for rendering coal dust inocuous. Close, well-made tubs running on good rails reduces the quantity deposited on the roads, and an important fact is pointed out by Mr Galloway, viz., that when the dust is properly damped on the roadways none is found to be deposited on the cross-timbers at all.

At Ynishir colliery a system of water pipes is applied with the object of introducing moisture into the air at points where its capacity has been increased by a rise of temperature. The first appliance used was a perforated lead pipe, which gave a fine spray with a pressure of 40 to 50 lbs., provided the holes were small enough, but the drawers broke the pipe because the spray wetted them when passing. A half-inch nipple with a hole drilled at the top and fitted with a threaded nut which could be screwed up so as to regulate the spray was next adopted, and it came out so fine that it could only be seen on holding a light on the other side of it. The roadways were not made wet enough to cause the floor to rise, but the air was saturated as nearly as possible to the dew point.

At Pochin Colliery, Mr Stratton had been experimenting on the feasibility of raising the temperature of the intake air and saturating it with steam so as to prevent it taking up moisture from the mine. This plan did well enough in summer time, but when the surface temperature fell below 45 degrees the apparatus they had was not sufficient to keep the mine free of dust. Except for 200 yards next the downcast pit, the heat and moisture made absolutely no difference to the roof, or in any way acted prejudicially to the mine. . However, it was thought undesirable by some to raise the temperature and introduce moisture, owing to its injurious effect on the roof, particularly where it was shale. Mr Hood had introduced steam into the intake, which had the effect of thoroughly damping floor, roof, and sides; but after a short time the roof began to crumble and waste away, and the temperature at the working faces was raised so high that the men complained of the pit being warm, and, owing to the heat and moisture, the same amount of work could not be got out of the horses, and in the result it cost a considerable amount of money in the district of the colliery in which it was tried.

At Dowlais, Mr Martin had been experimenting with a spray produced by compressed air in water, and obtained it as fine as desired.

Mr Hann had used salt, but found that it did not answer, as it only damped the dust for a short time.

A METHOD OF LIGHTING LOCKED SAFETY LAMPS.

By E. M. HANN.

THE method consists in passing two electrical conductors through the lamp into a position near the wick, where they are joined by a piece of platinum wire. One of the conductors can be turned round so as to take the wire out of contact with the wick. The current may be obtained either from a primary battery or a secondary cell. It is doubtful whether gas can be fired by the spark of low tension electricity, but in order to avoid any risk of this contact is made and broken in connecting lamp and battery in a sealed tube. The lamp is lighted by pressing it down on two buttons on the battery. The apparatus adds two ounces to the weight of the lamp. The batteries may be safely left to themselves in various parts of the workings, so that the miners may relight their lamps without having to go a long distance to a lamp station; and, of course, they do away with open lights altogether in those cases where there is no shot firing. This seems to be a simple and practicable expedient for the lighting of locked safety lamps by electricity.

ELECTRIC SAFETY LAMPS FOR MINERS.

By W. M. MORDEY.

THIS paper consists principally of the results of experiments made for the purpose of testing the behaviour of incandescent lamps in contact with explosive gas. They were made in a box 8in. by 4in. by 4in., and ordinary coal gas was used. The experiments are copied from the paper:—

Experiment I.—An incandescent lamp of 10 c.p., having a hole about ¼in. wide in the bulb, was placed in the box, which was then filled with the explosive mixture. The filament on being incandesced broke without causing an explosion. It was probable that the air in the bulb received no sensible admixture of gas while the filament lasted.

Experiment II.—With a larger hole, about ¼in. wide, in another lamp, an explosion was caused. The current was interrupted immediately, and the filament was found to be intact. This experiment showed that with free ingress of gas to an incandescent filament an explosion would occur.

Experiment III.—To find the effect of suddenly breaking a lamp in the explosive mixture while incandescent, a lamp was placed at the bottom of the box. A weight held by a cord at the top of the box was allowed to fall on and break the lamp. No explosion was caused. This showed that if a lamp were quickly broken, as by a fall of coal or by a blow, it would not fire gas. It appeared from the next experiment that the filament was broken before any gas could reach it.

Experiment IV.—Apparatus III., except that a button was arranged on the cord, so as to allow the weight to fall far enough to break the lamp bulb without reaching the filament. The mixture was exploded. Thus it would be seen that unless the blow which broke a lamp was a violent one an explosion might occur.

Experiment V.—A lamp was placed in a vessel which contained just enough water to cover the bulb. An iron rod was dropped on the lamp, breaking it, but causing no explosion. The filament was found to be broken, but whether by the water or rod was uncertain.

Experiment VI.—Apparatus as in V., except that a stop was placed on the iron rod to prevent it reaching the filament. No explosion occurred. Filament found to be broken by the water which filled the fractured bulb.

Experiment VII.—Lamp under water as in V. Passed a large current through the lamp in order to destroy the filament, and, if possible, obtain an arc considerable enough to break the bulb. Did not succeed in fracturing the bulb in that way, therefore the experiment had no special significance.

Experiment VIII.—A brass screw was fixed on one side of, and projecting into, the interior of the box. A flat metal spring was fixed in the box. One end of the spring

rested against, and made contact with, the screw. To the spring was attached a cord passing out of the box, by which the spring could be pulled away from the screw. The object of the experiments with this contact-breaker was to test the truth of the statement which had been made to the effect that the spark caused on breaking the circuit of an ordinary incandescent lamp would alone be sufficient to cause an explosion.

(a) Two 50 volt. 10 c.p. lamps outside of the box were connected in series, and connected to an accumulator shewing 100 volts., the spring and screw being included in the circuit. The circuit, it would be seen, resembled that of an ordinary 100 volt. lamp connected to suitable mains. Nothing that would have been likely to cause any avoidable extra current by self induction was inserted in the circuit.

The spark caused by breaking the circuit did not cause an explosion.

The experiment was repeated a number of times, breaking the circuit slowly to prolong the spark, and always with the same result.

(b) Apparatus as in (a), but with an electro-magnet of low resistance compared with the lamps (about 400 feet of No. 10 B.W.G. wire wound on a thick core of iron), inserted in series with the lamps in order to increase the spark by induction. The mixture was exploded.

(c) Apparatus as in (a). No electro-magnet in the circuit. A piece of carbon was attached to the spring so as to form one of the contact pieces. This gave a larger spark than (a), but the mixture was not exploded, although a jet of gas allowed to infringe on the contact pieces was ignited by the spark when contact was broken.

In (a) and (c), it was found possible, by separating the contact pieces very slightly, to maintain a small and thin arc for several seconds. The failure to explode the mixture, under the circumstances, was unexpected, in view of the action of the ordinary electric gas-lighter. It appeared that motion of the gases as well as, probably, considerable richness of the mixture was necessary. J. G.

Journal of the BRITISH SOCIETY of MINING STUDENTS. Vol. X.

THE DOUBLE STALL SYSTEM OF WORKING COAL.

By R. A. S. REDMAYNE.

THIS method of working, much practiced in Wales, has been recently introduced in the Durham coalfield at Eppleton Colliery for the purpose of working certain parts of the Maudlin seam where the roof was bad and the pavement subject to heaving, and, consequently, difficulty and cost was experienced in keeping the roads open. The working is 6 feet 9½ inches high, and where the roof is good the seam is still worked by the old system of pillar and stall. It was thought that the double stall system would cause a reduction in the length of roads required to be kept open, and at the same time increase the produce per man, and be attended with greater safety. The seam lies at a depth of 154 fathoms, its inclination is 1 in 14½, and its section is as follows:—

	Ft.	In.
Top Coal,	0	11
Stone,	1	8
Good Coal,	1	7
Foul Coal,	0	3
Good Coal,	0	11½
Splint,	0	3
Good Coal,	2	3
Stone band,	0	6
Bottom Coal,	1	0
	6	9

The stalls are driven 12 yards wide, leaving ribs 12 yards broad between them. A road 6 feet wide is kept along each side of the stall, having one side "fast" and the other "loose;" the loose side being supported by chocks set 3 feet apart. In the middle of

he stalls, the timber is drawn by special men as the face advances, and the roof allowed to fall. The faces are protected by three pairs of gears. The coal is brought down by wedging, no powder being used on account of the proximity of the waste. After the stalls have been driven 44 yards, the ribs are worked off, each road taking half the rib, or 6 yards of coal. At first these were worked backwards, but it was found that a saving of wood resulted when they were worked forward, or in the same direction as the stalls were driven. By this method of working, the air is usually taken up one side of the stall and down the other, and is dependant on a large number of screens placed on the drawing roads; and, although this can be avoided by holing through the ribs, the lengths of the currents do not conduce to good ventilation.

By double stall the cost for hewing, including yard work and deputy work, was 1/4·37, while by stoop and room the cost for these items, taking a proper proportion of room working and pillar working, was 1/5·74, or 1·37d per ton in favour of double stall, which, in addition, is stated to yield "a very much" better percentage of round coal. No separate account has been kept for the timber, but it is said "that it will undoubtedly be higher for double stall" than for stoop and room. It would have added value to the paper if to these two important points—percentage of round coal and cost of timber—determinate figures had been given. It was also found that the men in double stall produced 10 per cent. more coal per shift than the pillar and stall men,

The paper also deals with the results of the working of the Low Main Seam at Elemore Colliery by this method, and gives 0·34d per ton for the above items, and a production of 7 per cent. additional per man per shift in favour of double stall. J. G.

Journal of the SOCIETY of CHEMICAL INDUSTRY.
Vol. VI.

ON THE OCCURRENCE OF PETROLEUM IN A SHALE AT BROXBURN.

By D. R. STEUART.

When boring for shale to the north-east of Broxburn, at about 100 fathoms, the rods came up coated with semi-solid petroleum of a specific gravity of 0·842, and which set at 75° F. In a pit, 950 yards from the bore-hole, which had been sunk through the Broxburn and Dunnet shales, a cross-cut, at a depth of 155 fathoms and 10 fathoms under the last-mentioned shale, had a constant ooze of oil and brine from its sides, accompanied by a strong odour of gas. The specific gravity of the oil was 0·830, and its setting point 61° F. After being refined it gave the following result:—

	Sp. Gr.	Per Cent.
Light naphtha, ...	0·700	5·0
Light naphtha, ...	0·730	5·2
Burning oil, ...	0·802	34·1
Intermediate oil, ...	0·840	10·5
Lubricating oil, ...	0·865	16·7
Paraffin scale (melting point, 103° F.), ..		12·5
Loss in refining, ...		16·0
		100·0

Some of the bore-holes at Broxburn gave off considerable quantities of gas, which is of interest, as gas, brine, and petroleum are found associated in other parts of the world. Even assuming that the strata contained sufficient oil, it could not be pumped, as it is semi-solid, at a temperature of 61° F.

In discussion, it was suggested that this was not petroleum at all, but paraffin oil, which had been distilled from the fires known to have occurred in shale workings in the neighbourhood; but against this theory Mr Steuart stated that the water and gas rose to the surface at the bore, shewing that the strata was under considerable pressure; and that at the nearest fire, half a mile distant, and in a stratum 85 fathoms higher up, and which was put out in a fortnight, no crude oil had been found in the workings.

J. G.

Transactions of the MANCHESTER GEOLOGICAL SOCIETY. Vol. XIX., Part X.

NEW ELECTRIC LAMP ADAPTED FOR MINING PURPOSES.

MR J. S. BURROWS exhibited two portable electric lamps, weighing 7½lbs. and 5lbs. respectively, giving good light for twelve or thirteen hours. He compared the light to that of a full moon on a clear frosty night, and declared that it was as good as four Marsaut lamps. He thought the first cost of the lamp would be about 40s, but at present the Edison Company could not supply one under £3. The cost of installation would be about £130, but he was unable to give any particulars as to cost of upkeep. For handiness, the lamp appeared to give satisfaction. W. T.

Proceedings of the SOUTH WALES INSTITUTE OF ENGINEERS. Vol. XV.

THE HASARD COLLIERIES, AT MICHEROUX, BELGIUM.

By MORGAN WILLIAM DAVIES.

THIS paper is interesting, as being a history of the rise and progress of what is now a large Belgian colliery. It was started in 1842, and ten years later, when an adit of 1896 yards had been driven, and found the Hansard vein 39 inches thick, and a shaft had been sunk on its level, the total expenditure had been £3,236—an evidence of economy which augured well for the future of the undertaking. In April, 1857, a long level tunnel 3,499 yards in length and 9 ft. 10 in. by 8 ft. 2 in. was commenced to obtain railway connection and drain the water of the crop, and was finished in 1870. It is worked by an endless chain, and there are three turns of 4, 5, and 7 degrees respectively, round which the chain is passed by the usual arrangement of automatic inclines, and at each of these bends two men are stationed. The engines are 25½ in. diameter by 3 ft. 11 in. stroke, working expansively, and their cost, including mechanical appliances, boilers, buildings and foundations, was £5,600. The cost of hauling 1000 tons per day is 0·44d per ton per mile. The first chain worked for twelve years.

The paper gives details of the winding engines, loading appliances at pit bottom, ventilators, and mode of working; but the screening arrangements, which form so marked a feature at Belgian collieries, are not treated of in detail.

The colliery being at a distance from any centre of population, the want of house accommodation was severely felt, and the company not only built houses, but erected and furnished the Louise Hotel at a cost of £7,200, capable of boarding 200 men. This unique feature in colliery management is described in the paper as follows:—

"This commodious building was replete with every comfort for the workmen. It contained on the ground floor a coffee-room and dining-room for 100 persons, kitchens, bakehouse, baths and lavatories, laundry, store-room, and reading-room; on the second floor were the sleeping apartments, where the workmen were placed two or three in the same dormitory, but each in a separate bed. These small dormitories were formed by a lath partition out of a large room, having a clear height from floor to ceiling of 16ft. 4in. The partitions were 8ft. 2in. in height, and an opening of about 8in. was left between the bottom of the partition and the ground, so as to admit of ventilation, and to prevent the dust accumulating in the angles. The furniture of each bedroom consisted of an iron bedstead, a straw bed and mattress, a pair of linen sheets, two woollen blankets in summer and three in winter, a chair, and a cupboard—the whole costing £4."

An applicant for admission obtained from the manager a ticket, giving his name, occupation, and average earnings. Presenting this at the hotel, he received a bill of prices and particulars, as well as a book of coupons, each representing the value of a meal, the total cost being a little less than a shilling per day for board, lodging, and washing. At five o'clock he turned out and breakfasted on coffee and 10½ oz. of bread

and butter, and took a similar ration down the pit with him for his second breakfast. At two he ascended, went to the linen press and obtained his every-day clothes wrapped in a towel bearing his number; washed and dressed in a bath-room, supplied with both hot and cold water, and emerged therefrom with his "pit togs" tied up in the towel, which were bundled through a trap door into the laundry. He then dined on soup, 4½ oz. of meat, 1¾ lbs. of potatoes and vegetables, 3½ oz. of bread, and nearly a pint of beer. He could afterwards adjourn to the reading-room, which contained all the current newspapers. J. G.

TRANSACTIONS of the MIDLAND INSTITUTE of MINING, CIVIL, and MECHANICAL ENGINEERS. January, 1887.

ELLIOT'S PATENT MULTIPLE WEDGE.

By H. S. WALKER.

THIS paper is descriptive of a Multiple Wedge, patented by Mr Elliot, of the Hardy Patent Pick Company, Sheffield.

The author claims that it is an improvement on the old "plug and feather" in so far as that one of the principal disadvantages of the plug and feather is overcome by inserting two side pieces instead of only one as formerly, and driving them up separately and alternately, thereby doubling the expansive force obtainable with the same driving power.

In the paper some results are given of the work done, and shewing the comparative costs of bringing down the coal by the wedge as against gunpowder, the former doing the work of the latter at a cost of ·33 or ⅓ of a penny less per ton. A. L.

TRANSACTIONS of the MIDLAND INSTITUTE of MINING, CIVIL, and MECHANICAL ENGINEERS. May, 1887.

DESCRIPTION OF AN ARRANGEMENT FOR ARRESTING THE FALL OF COLLIERY CAGES IN CASES OF BREAKAGE OF ROPE.

By BERNARD E. CLARKE.

THIS is a new Safety Cage which, with slight modifications, can be made applicable to work on either wooden rail or wire rope slides. It is an invention of the author, who exhibited a working model of the cage at the Exhibition held in Elsecar last year. The invention seems to be simple and not liable to get out of order, only acting in the case of a rope breakage, no provision being made for detaching the cage in the event of overwinding taking place. In principle the invention is similar to those safety cages already in use.

The advantages claimed are—It is kept constantly in working order by the alternate slackening and tightening of the cage chains without any injury to the guides. In coming into action the strain is distributed at four points. The cage will not be stopped quite instantaneously, the action being like that caused by a brake. A. L.

Transactions of the NORTH STAFFORDSHIRE INSTITUTE of MINING and MECHANICAL ENGINEERS. Vol. VIII.

ON ERECTION OF STOPPINGS IN A MINE ON FIRE.

By A. R. SAWYER.

THE situation of stoppings having been selected, the work should be carried on expeditiously in intakes and return simultaneously. They should all be closed about the same time, but those in the return first, and all persons immediately withdrawn from the mine. The return should be closed first, for thus the products of combustion are prevented from escaping, and serve to dilute the gases and hinder the formation of an explosive mixture. Ten per cent. of the products of combustion is sufficient to destroy the explosive qualities of an otherwise explosive atmosphere. If the intake stoppings are first closed, the products of combustion are drawn off at the return, and the gas, being no longer diluted by the access of fresh air, soon arrives at the explosive point. Combustion goes on for some time after the stoppings are closed, and the internal pressure on them may be considerable if there is no outlet. This may be avoided by building a pipe fitted with a cock into each stopping, whereby the pressure is relieved as required. It is thought better not to dam back the gases escaping into the return too suddenly; and a Belgian engineer has described a contrivance whereby a stopping is finally closed slowly and gradually after the workmen have left the spot. The pipe built into the stopping is bent at right angles, and the outside end dips down into a tank. A pipe conveys water to this tank, and when the stopping is finished the water is turned on; and the workmen retire while the tank fills with water, and gradually cuts off the escape of gas as the head of water balances the pressure thereof. When concontraction of gas takes place in the enclosed area as it cools, the access of air is prevented by the water in the tank.

In cases of exceptionally great danger it may be advisable to erect temporary stoppings, and then to withdraw the workmen for a time. The permanent stoppings can afterwards be built with greater security, but this must be done outside those formerly put up and without disturbing them. These stronger stoppings should consist of a back wall from 9in. to 36in. thick, well plastered on the joints; then a front wall from 3ft. to 9ft. from the other, and the intervening space rammed full of sand and a little mortar or quicklime. The situation of the stoppings should be chosen where the roof and sides are most solid, and all loose material removed till a firm and air-tight jointing can be made.

THE APPEARANCE OF A SHOT-HOLE AFTER THE CHARGE HAS BEEN BLOWN OUT.

By A. R. SAWYER.

THE author considers that the effect of blown-out shots, the causes of which he summarises, are sufficiently well known in relation to their surroundings, but imperfectly understood in their effect on the appearance of the bore-hole itself, and his experiments were directed to the elucidation thereof. Compressed powder only was used, and that in charges of under one pound. It was observed that after a charge had been blown out the coal face round the bore-hole was coloured a bluish-grey shade from the deposition of some of the volatilized products of the exploded powder. This deposit is easily washed off, and soon disappears in presence of steam. In the shot-hole itself the angularities left by the drill are modified, but drill marks are made even more apparent by the explosion removing the dust left by the drill. In some cases dust or other matter purposely placed in the hole inside the charge was blown out along with it; in others it remained after the explosion. In two instances when grain powder was used with air space between it and the tamping, the paper forming the cartridge was left, partially burned, at the back of the hole. The stemming was generally completely removed, but sometimes part of it was afterwards found sticking to the sides undisturbed. A theory

has been advanced that, owing to the presence of carbonic acid preventing the passage of the flame inward, the explosion of a cartridge placed in the middle of the hole will not ignite another placed at the end of it. In order to test this, experiments were made with from 5 to 20 inches of air space between the cartridges, and in only one case was the back charge not exploded. In that case, it was enclosed in a pitch bag in a wet hole. As shewing the great heat generated at the instant of explosion, it is mentioned that two lamp gauzes placed inside the charge to maintain an air space were projected against a paper screen 8 yards in front of the hole, and burned an aperture of their own shape and size throughout. That substances placed at the back of the bore-hole were often thrown out with considerable force appears to point to the formation of at least a partial vacuum when the stemming suddenly yields to the pressure; or, more probably, that before that happens the gases generated have had time, under enormous pressure, to permeate the entire unoccupied space around all loose matter at the back of the hole, and carries it out with it at the moment of release. Clay placed at the back of the hole is not thus permeable and so remains there.

Shots may blow out without producing any breaks in the material; or they may partially shatter the hole. In one instance, numerous small bits of coal were found loose in the shot-hole discoloured on one side only. It was suggested that these might have been broken off after discharge by the action of the heat to which they were subjected. The effect upon external objects was only distinguishable at moderate distances. Paper screens within 7½ feet were not burned but only bespeckled by stemming. They were probably blown down before the flame reached the place where they were hung.

Mr Sawyer says--"I infer from these experiments that in a dry mine a blown-out shot would not leave any indications on an object 18 feet, much less 24 feet away. On a moist object, the effect of the heated gases of an explosion and the deposition of fine dust on all the surroundings would undoubtedly obliterate all indications."

The results of certain chemical tests applied to shot-holes are given with the opinion that such cannot be "safely relied upon by themselves after one or two days." Pieces of stemming smelt strongly of SH_2 and have an acid taste immediately after firing. In one case, after the lapse of a week, a powdery taste was detectable near the mouth, but was absent at the back of the hole. The charge was exploded in four experiments without displacing the stemming, and the gases must have escaped by the fuse-hole. The explosion was accompanied by a shrill whistling sound caused by the gases at high pressure escaping through the narrow aperture. In others an outlet was got by breaks in the coal. The conclusion is "that explosions are possible in the best ventilated collieries in which powder is used, and the better the ventilation the more disastrous the explosion from a powder-shot in a dusty mine when it does occur."

In the discussion printed in Vol. IX., page 151, a curious effect of a blown-out shot is recorded. A througher being driven upwards off a level was found full of gas by the fireman. This gas was not to be removed until the men left the pits. Meantime a shot blew out in a place off the opposite level 230 yards away in the direction of the intake. An inspection of the drift which contained the shot, made immediately after firing the shot, shewed the gas completely cleared away—the result, it was thought, of the vibration set up by the blown-out shot.

In two subsequent papers, Mr Sawyer gives result of experiments on chamber shots, and with water and gelatinous cartridges.

GOB FIRES and PIT STOPPINGS.

By Robert Oswald.

THREE cases of underground fires are here very briefly described. In the first it was necessary to build up two openings, and of these the return was heavily charged with "gob stink." A temporary stopping was made with trees laid transverely in a roughly prepared site in the heading or drift. The trees were bedded in mine dirt, and the thickness of the stopping thus formed was about 5 feet. Two upright trees were fixed

outside the horizontal ones, and mine dirt and sand to a thickness of 6 feet was piled up between the temporary stopping of timber, and the permanent brick wall. While the latter was being erected an explosion occurred, but this the wooden stopping successfully resisted. The peculiar feature of the other cases was the difficulty of gaining access to the seat of the fire, but the means whereby this was overcome cannot be made intelligible apart from the sketches. In dealing with gob fires, the author has "found benefit from using steam, salt, sand, wood, calcined mine ash (riddled), water, and clay."

ARRANGEMENTS for PREVENTING ACCIDENTS at LEVEL LANDINGS IN CAGE DIPS and SHAFTS.

By A. R. SAWYER.

SEVERAL of the contrivances described in this paper were devised by the author to prevent the recurrence of accidents which he was called upon to investigate; or to reduce the risk in cases which came under his notice as inspector. Some are automatic, and others require to be operated by the workmen, but in such a way as to minimise the risk accompanying a mistake on his part. To give a clear idea of them in notes is impossible, and those interested are referred to the paper itself.

THE COMPRESSED AIR POWER SYSTEM.

By JOHN STURGEON.

Vol. IX., p. 45.

THIS paper reviews the capability of the system to meet the wants of a community requiring mechanical power, and the saving which it is possible to effect by co-operation and by centralisation of the plant required for its production. The distribution of power by means of steam and the utilisation thereof for heating purposes has been adopted in some American cities. The Birmingham scheme adopts compressed air in place of steam. When application was made to Parliament for power to establish the system in Birmingham, the Corporation commissioned Sir F. Bramwell and Mr Piercy to inquire and report thereon. The reports dealt with the cost of steam power in the town. A number of steam engines were selected, and continuous diagrams taken from them for several days. These, it was found, were only required to yield from one-third to one-seventh of their maximum power throughout the day; and the coal consumed varied from 8·5lbs. to 36lbs. per ind. H.P. per hour. The high rate of coal consumption was mainly due to the intermittent work required from the engines, and this could be much decreased by distribution of power from a central establishment. A description and drawings of the plant being erected is given, and the paper concludes with a summary of the purposes to which the compressed air may be applied, and of the benefits, mechanical, commercial, and sanitary, that will accrue from its application. J. H.

TRANSACTIONS of the CHESTERFIELD and MIDLAND COUNTIES INSTITUTION of ENGINEERS. Vol. XVI.

A NEW ELECTRIC EXPLODER FOR FUSES.

By G. E. SMITH.

THIS is a little dynamo fitted in a case about 7″ cube, and weighing 5½ pounds. An incandescent lamp can be attached to the machine for use in making an examination after firing a shot. Experimentally it has been made to explode two fuses simultaneously through an artificial line, equal to five miles, in addition to forty yards of wire, such as would be used in a mine. The cost is about 40s.

A SIMPLE SAFETY BLASTING CARTRIDGE.

By W. H. ROUTLEDGE.

THE contrivance here described is an application of the water cartridge to powder. The powder is enclosed in a chamber surrounded by a case of tin or glass containing water. The explosion is produced by electricity at the inner end of the cartridge. The case can be filled with water when about to be used. It is claimed for this cartridge that the cost is a great deal less than for those of dynamite, and that in tests no sparks or flame have ever been observed.

TRANSACTIONS OF THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

VOLUME XXXVI. PART IV.

At the meeting of this Institute, held in the Theatre of the Newcastle Exhibition on 6th August last, Sir Isaac Lowthian Bell gave his presidential address, which took the form of a review of the progress of the manufacturing industries of the kingdom during the last 50 years. The chief factor in this astonishing progress has been our possession of unlimited resources of cheap coal and cheap iron, which has enabled us to lead the way in building and equipping railways in our own country and the world at large. Less than 50 years ago all the railways in Europe did not exceed 300 miles in length. There are now 280,000 miles, of which 17,000 miles are in the United Kingdom, conveying 700,000,000 of passengers and 270,000,000 tons of goods annually. Sir Isaac claims that the first idea of a railway originated 250 years ago with a colliery owner near Newcastle, named Beaumont, who made his rails of wood; but it was not till 1821 that malleable iron rails were made expressly for railway purposes. In that year the directors of the Stockton and Darlington Railway decided to lay a portion of their railway with a malleable iron rail invented by Mr Birkenshaw, of Bedlington, Northumberland. They were rolled in lengths of 12 to 15 feet, and weighed 28 lbs. per yard. This was as heavy a mass as the machinery of these days could deal with, and it affords a striking contrast to the practice of the present day, when we have a united force of 7000 horse-power turning out upwards of 400 tons of 82-lb. rails in twelve hours, in lengths of 120 feet. The development of the locomotive in its first stages was slow. From the time when Mr Hedley placed the first engine on the Wylam Colliery Railway (1813), capable of running 5 miles per hour, till the time when Stephenson built the "Rocket," capable of running 30 miles per hour, a period of seventeen years had elapsed. This slow rate of progress was mostly due to the want of the machine tools and appliances with which we are now all so familiar. Side by side with the development of the railway and the locomotive, we have the enormous development of steam navigation of late years, chiefly by taking advantage of the expansive property of steam. To such an extent has this been carried that 350 tons of coal are now doing the work which only a short time ago required 750 tons. In dealing with the question of the heat evolved by the combustion of coal, into which he entered pretty fully, the President went back to the time (120 years ago) when steam power was beginning to be applied to the drainage of coal pits; then the duty performed was only 64,000 lbs. of water raised one foot per lb. of coal burned, by a purely atmospheric engine. When Watt invented the separate condenser, and proceeded in addition to work his steam expansively, he raised the duty to 316,000 foot lbs. Since Watt's time, by means of higher pressed steam and better constructed engines, the duty has been raised to 1,000,000 foot lbs. Great as this advance is, Sir Isaac is careful to point out that it represents only 9 per cent. of the actual power of the fuel, as, according to Joule, the full energy in one lb. of coal is equal to raising 11,422,000 lbs. one foot high.

In continuing his address, the President touched on the question of the exhaustion of coal,

pointing out how rapid had been the increase of output during the last 25 years, and urging the necessity of economising all our resources in this important commodity. In dealing with the iron manufacture, Sir Isaac notes all the recent improvements in that important industry, points out how greatly foreign countries have increased their facilities for supplying themselves with native made iron, and in order that we may still keep our position in the forefront of these industries he urges on all connected with them to take full advantage of the educational facilities which are now being so fully provided in most of our centres of industry. J. P.

THE MANCHESTER ASSOCIATION OF ENGINEERS.

INDICATOR DIAGRAMS.

By Mr James Hartley.

There is little doubt that there are many owners of steam engines who appear not to know or care anything about the condition of their engines, while others, who devote a little attention to the use of the indicator, are content if the diagrams show the valves opening and closing about the proper time; but the correct use of the indicator is a most important subject which has never yet received from steam users the attention which its importance deserves.

In this paper, Mr Hedley puts before the Association a series of 101 diagrams taken in the course of his professional work from almost every class and condition of engine. He describes each diagram separately, pointing out, from the evidence given by it, where the defects are to be found, and showing conclusively the value of careful and reliable indicating. Numerous instances are given where, by the simple process of adjusting the valve gear, &c., a saving of 15 to 25 per cent. has been made in the fuel used. To those interested in the proper working of steam machinery, the perusal of this paper cannot fail to be interesting. J. P.

TRANSACTIONS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

GAS LIGHTING BY INCANDESCENCE.

By James Dredge, London, England.

There are many reasons why progress in the general application of the electric light, especially as regards its domestic use, has been far less rapid in Britain than in America, but the low price at which gas can be produced in the former country is the principal cause. This is likely to be still further accentuated should gas lighting by incandescence prove to be the success claimed for it, as a cheap gas of a low illuminating power is quite suitable for this system, and a saving of 45 per cent. in quantity is effected by it.

Gas lighting by incandescence has already been made the subject of several patents. They all agree in the general principle of heating a cap of finely woven, gauze composed of Platinum, Iridium, Zirconium, Magnesium, or other highly refractory metal, to a white heat by making a proper and intimate mixture of the gas and air with the cap, and which produces on combustion a flame of intense heat, raising the cap to incandescence. These burners are beginning to make their way in this country, and the light given off both for steadiness and brilliancy, is far in advance of the gas jet. J. P.

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Bell, James, San Fermin Mining Company, Portugalete, Bilbao, - - - - - - 1881
Birrel, George, Dunfermline, - - - - 1880
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Brown, Thomas M., Lanemark Colliery, New Cumnock, - 1880
Brown, Walton M., 3 Summerhill Terrace, Newcastle-on-Tyne, - - - - - - 1887
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Buchanan, D. C. R. C., Drumpellier, Coatbridge, - - 1881

Cameron, Robert, Balbardie Colliery, Bathgate, - - 1879
Cameron, William J., Finnie Street, Kilmarnock,- - 1885
Campbell, Archibald, Redding Collieries, Polmont Station, 1883
Carlow, Charles, The Fife Coal Company, Leven, - - 1879
Clark, James, Ormiston Station Colliery, Ormiston, - 1880
Clark, Robert, Arniston Colliery, Gorebridge, - - 1883
Colquhoun, James, Tredegar Iron Works, South Wales, - 1882
Connal, John, 123 St. Vincent Street, Glasgow, - - 1882
Cowan, David, Carron Iron Works, Falkirk, - - 1879
Coats, William A., Ferguslie House, Paisley, - - 1884
Craig, William, Publisher, Coatbridge, - - - 1887
Crampton, Jeremiah, Union Gold Mining Co. (Limited), Barberton, Transvaal, - - - - 1887
Cuninghame, Alex., Carnbroe Iron Works, Coatbridge, - 1880
Cuninghame, J. C., 127 St. Vincent Street, Glasgow, - 1879
Cuninghame, John, 127 St. Vincent Street, Glasgow, - 1879

Dalzell, John B., Portland Park, Hamilton, - - 1881
Darling, John, Cleugh Gas Coal Works, Forth, Lanark, - 1880
Denniston, R. B., 79 Princes Street, Dunedin, N.Z., - 1886
Dick, Alexander, Denby Colliery, Derby, - - - 1884
Dixon, James S., Bent Colliery, Hamilton *(President)*, - 1879
Dougall, George, Bonnymuir Works, Bonnybridge, - 1884
Duff, William, 79 Finnieston Street, Glasgow, - - 1886
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Durie, John, Elphingston Colliery, Tranent, - - 1880

Ferguson, Peter, 19 Royal Exchange Square, Glasgow, - 1885
Forgie, James T., Twechar, Kilsyth, - - - 1878
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Frame, Alexander, Larkhall, - - - - 1887
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Galloway, John, Ardrossan, - - - - 1879
Galloway, Robert L., 98 West George Street, Glasgow, *(Councillor)*, - - - - - 1884
Galloway, T. Lindsay, Argyll Colliery, Campbeltown, - 1880
Gardiner, David, Meiklehill Colliery, Kirkintilloch, - 1881
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Gilmour, Allan, Portland Colliery, Kilmarnock, - - 1879
Glen, Robert, Eastfield Colliery, Cambuslang, - - - 1881
Grant, A. M., Townholm Engine Works, Kilmarnock, *(Councillor)*, - - - - - 1884
Grant, T. M., Clyde Locomotive Works, Springburn, Glasgow, - - - - - - 1879
Gray, Archibald, Middleton House, Dalry, Ayrshire, - 1883
Gray, Archibald, Keyshill, Dalry, - - - - 1881
Gray, John, Spencerfield House, Hamilton, - - 1882
Grierson, Thomas, Glebe Colliery, Douglas, - - 1881
Griffiths, A., Bonnybridge, Denny, - - - 1887

Haggie, P. S., Gateshead-on-Tyne, - - - 1887
Hamilton, Lord, of Dalzell, Motherwell, - - - 1881

Hamilton, Robert, Derwent Villa, Crosshill, Glasgow, - 1887
Hamilton, Thomas, 101 West Regent Street, Glasgow, - 1879
Henderson, Norman M., Broxburn Oil Works, Broxburn, 1884
Hill, Alexander, Mina de Tinoca, Campo Maier, Portugal, 1883
Hill, Laurence, 2 Alfred Terrace, Hillhead, Glasgow, - 1883
Hodson, James, Liverpool Road, St. Helens, Lancashire, - 1880
Hogg, John, Victoria Engine Works, Airdrie, - - 1884
Hood, Archibald, 6 Bute Crescent, Cardiff, - - 1879
Hood, James A., Rosewell, Mid-Lothian, - - - 1887
Hurll, Mark, Woodneuk, Gartcosh, - - - 1880
Hyslop, Jonathan, The Cottage, Airdriehouse, Airdrie, - 1881

Irvine, C. Maclaren, Fence Colliery, Blackwood, Lesmahagow, - - - - - - 1880

Jamieson, James Auldjo, 66 Queen Street, Edinburgh, - 1885
Jenkins, James G., 33 Renfield Street, Glasgow, - - 1882
Johnston, David, 12 York Street, Glasgow, - - 1881
Johnstone, Hugh, Portland Park, Hamilton, - - 1879
Johnstone, Ronald H., 75 West Nile Street, Glasgow, - 1879

Keith, Daniel, Arden Lime Works, Barrhead, - - 1883
Kesson, Andrew, Bothwell, - - - - 1885

Landale, David, The Binn, Burntisland, - - - 1883
Lewin, Henry W., Drumpellier, Coatbridge, - - 1882

M'Callum, John A., jun., 12 Waterloo Street, Glasgow, - 1887

M'Creath, George W., 95 Bath Street, Glasgow, - - 1879
M'Creath, James, 95 Bath Street, Glasgow (*Past President*), 1879
M'Culloch, David, Vulcan Works, Kilmarnock, - - 1885
M'Culloch, John, 7 Melrose Street, Glasgow, - - 1879
M'Culloch, Thomas, Vulcan Works, Kilmarnock, - - 1885
Macdonald, Symington, The Great Kanawha Colliery Co. (Limited), Mount Carbon, West Virginia, U.S.A., - 1880
Mackay, Andrew, Grangemouth Coal Co., Grangemouth, - 1879
M'Kenzie, Kenneth, New Bank Colliery, New Cumnock, - 1880
M'Kenzie, William, Newbattle Collieries, Dalkeith, - 1880
M'Killop, James, Slamannan, - - - - 1886
M'Kinnell, William, Clyde Steel and Iron Works, Sheffield, 1887
M'Laren, Robert, Crofthill Place, Uddingston, - - 1882
M'Laren, William, Orchards, Bellshill, - - - 1884
M'Lauchlan, J. D., 35 South Bruntsfield Place, Edinburgh, 1882
M'Nab, John, Flemington Coal Co. (Limited), Cambuslang, 1881
M'Naughton, James, 11 West Regent Street, Glasgow, - 1880
M'Pherson, Gilbert, jun., Stair, Ayrshire, - - - 1887

Marshall, R. A., 170 Hope Street, Glasgow, - - 1879
Miller, Thomas H., Vulcan Foundry, Coatbridge, - - 1885
Mitchell, George A., 67 West Nile Street, Glasgow, - 1881
Moffat, Peter, Mount Albion, Herberton, North Queensland, - - - - - - 1881
Moore, Robert T., 134 St. Vincent Street, Glasgow, - 1880
Morrison, David G., - - - - - 1885
Morison, John, Newbattle Collieries, Dalkeith, - - 1879
Morton, James, Manor Park, Blairhill, Coatbridge, - 1880

Mungall, Henry, Cowdenbeath Collieries, Cowdenbeath (*Councillor*), - - - - - 1880
Munro, R. D., 141 Buchanan Street, Glasgow, - - 1883
Murdoch, Alexander, 11 West Regent Street, Glasgow, - 1886

Nasmyth, A. H., Donibristle Colliery, Crossgates, Fife, - 1880
Nasmyth, J. A., Donibristle Colliery, Crossgates, Fife, - 1883
Neilson, George, Summerlee Iron Works, Coatbridge, - 1880
Neilson, John, Summerlee Iron Works, Coatbridge, - 1883
Nimmo, John, 12 St. Giles Street, Edinburgh, - - 1885

Oki, Yoshitada, 60 Robertson Street, Glasgow, - - 1887
Ormiston, A. R., Gartness Coal Coy., 19 Waterloo Street, Glasgow, - - - - - - 1880
Ormiston, James, Mount Vernon, Glasgow, - - 1880

Park, John, Stonelaw Colliery, Rutherglen, - - 1881
Paterson, A. G., Earl of Rosslyn's Collieries, Dysart, - 1886
Paul, Fred. W., Hallside Steel Works, Newton, - - 1887
Paul, James, 7 Shandwick Place, Edinburgh, - - 1879
Penman, Robert, 377 Dalmarnock Road, Glasgow, - 1887
Pickering, John, 54 West Regent Street, Glasgow, - 1883
Pratt, George, 29 Waterloo Street, Glasgow, - - 1879

Rankin, John, jun., Drumgray Colliery, Airdrie, - - 1881
Rankine, David, 75 West Nile Street, Glasgow, - - 1879
*Reid, John, Loanhead House, Baillieston, - - 1883

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*Deceased.

Reid, John, 112 Bath Street, Glasgow, - - - 1883
Reid, Joseph, 67 St. Enoch Square, Glasgow, - - 1887
Robertson, David, 21 Pitt Street, Glasgow, - - 1880
Robertson, D. A. W., Clydeside House, Renfrew, - 1882
Robertson, Dr J. R. M., Clydeside House, Renfrew, - 1886
Robertson, William, 123 St. Vincent Street, Glasgow, - 1879
Rowan, Fred. J., 121 West Regent Street, Glasgow, *(Councillor)*, - - - - - 1883
Roxburgh, Alexander, Alloa Coal Co., Alloa, - - 1880
Roy, William, Limerig and West Drumclair Collieries, Slamannan, - - - - - 1879
Russell, Archibald, jun., Avongrange, Hamilton, - - 1882
Russell, George, Summerlee Iron Works, Coatbridge, - 1883
Russell, P. B., Newfield, Hamilton, - - - 1887
Russell, Robert, Coltness Iron Works, Newmains, - 1878

Sharp, Robert, Coatbridge, - - - - 1886
Smart, James, Balgreen, Hamilton *(Vice-President)*, - 1879
Smith, Eustace, jun., St. Lawrence Ropery, Newcastle-on-Tyne, - - - - - - 1885
Smith, George W., Port Elizabeth, South Africa, - - 1883
Smith, James, Saracen Colliery, Possil, - - - 1884
Spowart, Thomas, Broomhead, Dunfermline, - - 1881
Stafford, Thomas W., 157 West George Street, Glasgow, - 1885
Stevenson, Hugh, 21 Clyde Place, Glasgow, - - 1884
Stewart, Alex., Tharsis Mines, Huelva, Spain, - - 1879
Stewart, Robert, 1 Dixon Street, Glasgow, - - 1883
Strain, Hugh, jun., Rigg Colliery, Airdrie, - - 1887

Sutherland, Donald, Queen Street, Newcastle-on-Tyne, - 1885
Sutherland, Henry, - - - - - 1884

Terris, Henry, Clackmannan Colliery, Clackmannan, - 1880
Thomson, Alex., 112 Bath Street, Glasgow, - - 1880
Thomson, Charles, Calder Iron Works, Coatbridge, - 1879
Thomson, David, Craigderran House, Cardenden, - 1887
Thomson, Thomas, 38 New Row, Dunfermline, - - 1884
Thorneycroft, Wallace, Merryton Colliery, Hamilton, - 1887
Thornton, Peter, Crofthead, Fauldhouse, - - - 1878
Thornton, Thomas, - - - - - 1879
Todd, John, Banknock Collieries, Denny, - - 1888
Topping, R. M., Blantyre Foundry, Blantyre, - - 1879
Torrance, James W., 81 St. Vincent Street, Glasgow, - 1881
Tweedie, James A., Carron Works, Falkirk, - - 1887

Waldie, James, 103 Leith Walk, Leith, - - - 1882
Waldie, James F., 53 Waterloo Street, Glasgow, - - 1883
Walker, James, 66 Waterloo Street, Glasgow, - - 1883
Walker, James P., Dalmellington Iron Works, Ayrshire, - 1880
Walker, William H., Springwells Colliery, Airdrie, - 1880
Wallace, James, Wester Gartshore Colliery, Kirkintilloch, 1882
Watson, John, Earnock, Hamilton, - - - 1879
Watson, William, Bank Street, Coatbridge, - - 1886
Weir, Alexander, Castlecary, Kilsyth, - - - 1881
Weir, Thomas D., 97 West Regent Street, Glasgow, - 1884
Whitelaw, Thomas, Dalzell Colliery, Motherwell, - - 1879
Whyte, Robert, Royal Exchange, Glasgow, - - 1887

Williamson, John R., 12 St. Andrew Square, Edinburgh, - 1882
Wilson, Andrew, Dalzell Estate Office, Motherwell, - 1880
Wilson, John, Alderston, Mid-Calder, - - - 1881
Wilson, John, 69 Great Clyde Street, Glasgow, - - 1879
Wilson, William, Lochhead Works, Dunfermline, - 1883
Wood, James, 40 St. Enoch Square, Glasgow, - - 1880
Wylie, John, Clifton Iron Works, Coatbridge, - - 1883

Young, John, Baljaffray Colliery, New Kilpatrick, - 1881
Young, Robert, 37 West George Street, Glasgow, - - 1882
Young, William, 204 Stobcross Street, Glasgow, - - 1885
Yates, Andrew, Grange Colliery, Kilmarnock, - - 1881

ORDINARY MEMBERS.

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Allan, John, Calder Iron Works, Coatbridge, - - 1881
Allan, William, Woodyett and Dennymill Mines, Denny, - 1881
Allardice, James, Eastfield Colliery, Cambuslang, - - 1881
Anderson, David, Cowdenbeath Colliery, Cowdenbeath, - 1881
Anderson, George, Barkip Colliery, Dalry, - - 1880
Anderson, George, Ferniegair Colliery, Hamilton, - 1885
Anderson, James, Wishaw Ironworks, Wishaw, - - 1887
Anderson, John, Lochgelly Iron and Coal Coy., Lochgelly, - 1880
Andrew, Robert, Minas de Aznacóllar, Seville, Spain, - 1880
Andrew, William, Lassodie Colliery, Dunfermline, - 1880
Angus, George S., - - - - - - 1884
Archibald, William, Haywood Colliery, Lanark, - - 1879
Arnott, Thomas, Clyde Cottage, Tollcross (*Councillor*), - 1879

Baird, Dugald, Raith Colliery, Cowdenbeath, - - 1887
Baxter, Robert, Niddrie Collieries, Portobello, - - 1880
Begg, John, - - - - - - - 1879
*Beith, Andrew, 28 Regent Street, Portobello, - - 1885
Beith, Robert, Loanhead Colliery, Loanhead (*Councillor*), - 1878
Benson, James R., West Longrigg, Airdrie, - - 1887
Beveridge, James, Linlithgow Oil Coy., Linlithgow, - 1882
Beveridge, John, Kelty Colliery, Blairadam, - - 1881

*Deceased.

Blackwood, James, Albany Place, Hamilton (*Librarian*), - 1887
Blyth, Archibald, Bent Colliery, Hamilton (*Treasurer*), - 1878
Bowie, Hunter, Lugar Iron Works, Old Cumnock, - 1881
Bowser, C. H., 13 Royal Crescent, Glasgow, - - 1885
Brown, George, Longriggend Colliery, Airdrie, - - 1880
Brown, James, Caledonian Cottage, Morningside, - - 1887
Brown, John, 43 Lowries Place, Duke Street, Hamilton, - 1887
Brown, Robert, Drumpellier Colliery, Coatbridge, - 1883
Brown, Peter, Martin's Crescent, Airdrie, - - - 1881
Brownlie, Archibald, Lassodie Colliery, Dunfermline, - 1883
Bryden, David, Coylton, Ayr, - - - - 1881
Buchanan, John, Calderbank Colliery, Airdrie, - - 1887
Burt, Hutchison, Fordell Colliery, Crossgates, Fifeshire, - 1885

Cairns, William, Muiredge Colliery, Buckhaven, - - 1887
Caldwell, James, Pumpherston, Mid Calder, - - 1887
Campbell, Alexander, Burgh Colliery, Irvine, - - 1882
Campbell, Thomas, Spindleside Colliery, Omoa, Motherwell, - - - - - - 1881
Carey, William, Grange Colliery, Bo'ness, - - 1882
Carmichael, Robert, Earnock Colliery, Hamilton, - 1880
Clarke, J. A., Ayr Colliery, Ayr, - - - - 1880
Clark, William, 95 Bath Street, Glasgow, - - - 1883
Clelland, James, Carronhall Colliery, Falkirk, - - 1879
Cochrane, Joseph, Gray's Buildings, Harthill, Whitburn, - 1883
Cochrane, Neil, Glasgow Canadian Phosphates Co. (Limited), Buckingham, Ottawa, Canada, - - 1881
Cowan, James, Cadzow Colliery, Hamilton, - - 1885

Cranston, David, Woodend Colliery, Armadale, - - 1880
Crichton, A. H., Hillside, Linlithgow, - - - 1880
Crockett, John D., Curran House, Dungannon, - - 1880
Crookston, Andrew, Wemyss Colliery, Dysart, Fife, : 1880
Crookston, Thomas, Townhill, Dunfermline, - - 1879
Cunninghame, Archibald, Eglinton Iron Co., Dalry, - 1881
Cuthbert, Robert, Gauchalland Colliery, Galston, - - 1881

Danks, Henry, Green Colliery, Wishaw, - - - 1880
Davies, William, Barncluith Colliery, Hamilton, - - 1887
Dewar, Peter, Braidwood Colliery, Carluke, - - 1878
Dewar, Robert, Harthill Colliery, Whitburn, - - 1881
Dewar, Thomas, Glencleland Colliery, Wishaw, - - 1881
Drinnan, John, Trowell Moor Colliery, Nottingham, - 1880
Duncan, George, Leven Colliery, Leven, - - - 1881
Dunsire, Andrew, Cameron Colliery, Windygates, - 1883

Easton, Alexander, 13 South Bridge Street, Bathgate, - 1883

Falconer, Thomas, 40 Witch Road, Kilmarnock, - - 1880
Faulds, Alexander, Dalzell Colliery, Motherwell, - - 1878
Ferguson, David, Cadzow Colliery, Hamilton, - - 1878
Ferguson, Duncan, Lochore and Capeldrae Collieries, Lochgelly, - - - - - - 1880
Ferguson, William, Byrehill Row, Kilwinning, - - 1887
Findlay, Hugh, 78 Hill Street, Kilmarnock, - - 1886
Forbes, Alexander, Allanton Colliery, Hamilton, - - 1885
French, John, Millcroft Cottage, Rutherglen Road, Glasgow, 1879

Frew, James, 5 Greenhill, Waterside, Ayr, - - 1887
Frew, William, Barncluith Colliery, Hamilton, - - 1887
Frew, William, Quarter Colliery, Hamilton, - - 1887
Fulton, David, Dalquharran, Maybole, - - - 1881

Gardner, Thomas, jun., Auldton Collieries, Dalserf, - 1881
Gavin, James, Udston Colliery, Hamilton, - - 1880
Gemmel, James, Newfield, Rutherglen, - - - 1878
Gibb, Robert, Daldowie Colliery, Broomhouse, - - 1887
Gibson, William K., Craigbank, New Cumnock, - - 1886
Gilchrist, James, Earnock Colliery, Hamilton *(Councillor)*, 1878
Gilmour, James, Duchray Colliery, Coylton, Ayr, - 1881
Goldie, James, Springhill Colliery, Shotts, - - 1887
Goodwin, George, Gun Place, Woodside Street, Coatbridge, 1885
Gordon, Gavin C., Knightswood Colliery, Maryhill, - 1878
Grahame, John, Lightshaw Row, Muirkirk, - - 1887
Grant, John, Bog and Home Farm Collieries, Larkhall, - 1878
Grant, Robert, Bardykes and Hallside Colliery, Newton, - 1881
Gray, David, Chapel Colliery, Newmains, - - 1885
Gray, John, Shields Colliery, Motherwell, - - 1885
Gray, William, Common Cottage, Auchinleck, - - 1880
Gray, William, Townlands Colliery, Hamilton, - - 1885
Green, William, Galston Colliery, Galston, - - 1883
Greig, James, Arden Works, Airdrie, - - - 1887

Haddow, John, Arniston Colliery, Gorebridge, - - 1879
Hamilton, James, 97 North Frederick Street, Glasgow, - 1883
Hamilton, James, Bulli P.O., Wollongong, New South Wales, 1883

Hardie, James, Hopetoun, Winchburgh, - - - 1882
Hart, John, Clyde Iron Works, Tollcross, - - 1881
Hart, Robert, care of Mr Stafford, 157 West George Street, Glasgow, - - - - - - 1887
Hastie, James, Greenfield Colliery, Hamilton *(Councillor)*, 1887
Hastie, William, Gilmilnscroft, Auchinleck, . - 1881
Henderson, Andrew, Muiravonside Colliery, Bowhouse, Linlithgow, - - - - - 1880
Henderson, William, Levenseat, Fauldhouse, - - 1884
Herd, Samuel, Balgonie, Markinch, - - - 1885
Herd, Thomas, Dunnikeir Colliery, Kirkcaldy, - - 1880
Hill, James, Dalmellington, - - - - 1880
Hillhouse, William, Bonnyton Cottage, Kilmarnock, - 1883
Hogg, James, Rochsoles Colliery, Airdrie, - - 1887
Hogg, John, North Motherwell Colliery, Motherwell *(Councillor)*, - - - - - 1878
Hogg, William, Carnmoor Cottage, Forth, by Lanark, - 1881
Howat, John T., Eglinton Iron Works, Kilwinning, - 1883
Howat, Robert M., Hopetoun Works, Winchburgh, - 1886
Howat, William, Dunsyston Colliery, Clarkston, Airdrie, - 1886
Howat, William, Southrigg Colliery, Armadale, - - 1886
Hunter, Adam, Bourtreehill Colliery, Dreghorn, - - 1885
Hunter, A., Alloa Colliery, Alloa, - - - - 1880
Hunter, Andrew, Orbiston Colliery, Bellshill, - - 1878
Husband, John, Kirkwood Colliery, Coatbridge, - - 1881

Ireland, Thomas, Largoward, St. Andrews, - - 1881
Irvine, William, 7 Auchenstarry, Kilsyth, - - 1887

Jackson, Douglas, Ross Colliery, Hamilton, - - 1880
James, William, Niddrie Colliery, Portobello, - - 1883
Jamieson, Alexander, Balgonie Colliery, Markinch, - 1878
Jamieson, William, Rosebank Cottage, Broxburn, - 1879
Jeffrey, William, Ladylands Colliery, Shotts, - - 1888

Kennedy, Alexander, Broxburn Oil Works, Broxburn, - 1882
Kerr, Archibald, Barncluith Colliery, Hamilton, - - 1881
Kerr, Archibald, Bankend Colliery, Lesmahagow, - 1881
Kerr, William, Barncluith Colliery, Hamilton, - - 1885
King, Henry, Drumpellier Colliery, Coatbridge, - - 1887
Kirkwood, William, 38 Ferguslie Street, Paisley, - - 1880
Knox, James, Allanton Colliery, Newmains, - - 1880

Laird, Andrew, 1 Corunna Street, Glasgow, - - 1883
Landor, Francis, Brownlie Colliery, Carluke, - - 1885
Legat, A. S., Loanhead Colliery, Edinburgh, - - 1879
Leggate, John, 191 Merry Street, Motherwell, - - 1881
Lindsay, Thomas J., Castlehill Iron Works, Carluke, - 1885
Lithgow, Thomas, Langbyres Colliery, Omoa, Motherwell, 1882
Livingstone, Archibald, Pentland Oil Works, Loanhead, - 1880
Love, John, Shottstown, Penicuik (*Councillor*), - - 1878
Love, John, Portland Iron Works, Hurlford, - - 1882
Love, William J., Shotts Iron Coy., Shotts, - - 1881

M'Beth, Peter, Callander Coal Co., Falkirk, - - 1879
M'Cairn, Nicol, 7 Drum Terrace, Easter Road, Edinburgh, 1881
M'Culloch, John, Jawcraig Colliery, Slamannan, - - 1888

M'Culloch, William, Linkieburn House, Muirkirk, - 1881
M'Donald, John, Greenhill Colliery, Holytown, - - 1880
M'Farlane, Walter, Mossvale Cottage, Chryston, - - 1882
M'Gee, John, Tillicoultry Colliery, Tillicoultry, - - 1880
M'Gown, John, Gilmerton Colliery, Liberton, - - 1883
M'Gill, James, Pentland Oil Works, Loanhead, - - 1887
M'Kay, James, Roughrigg Colliery, Airdrie, - - 1880
M'Kenzie, Daniel, Wishaw Coal Co., Motherwell, - 1886
M'Kenzie, John, Lambhill, Bishopbriggs, - - 1886
M'Knight, John, - - - - - - 1886
M'Neil, James, Glencleland House, Wishaw, - - 1878
M'Phail, James, Balbardie Colliery, Bathgate, - - 1884
M'Pherson, Gilbert, Holmes Colliery, Galston, - - 1881

Makepeace, Hugh R., Evenwood and Tees Hutton Collieries, Evenwood, Bishop Auckland, Co. Durham, 1881
Malcolm, James, Inkermann Works, Paisley, - - 1879
Martin, Robert, Ormiston House, Ormiston, - - 1879
Martin, William, Douglas Park Colliery, Bellshill, - 1881
Mathie, James, Cornsilloch Colliery, Larkhall, - - 1879
Middleton, George, Westburn Colliery, Newton, - - 1886
Millar, William, Townlands Colliery, Hamilton, - - 1883
Milligan, Peter, Cleland, - - - - - 1884
Moffat, James, Allanton Colliery, Hamilton, - - 1885
Moodie, Thomas, Devon Colliery, Alloa, - - - 1881
Morton, John, Rankinston Works, Ayr, - - - 1880
Morton, R. M., Ansonhill House, Crossgates, Fife, - 1879
Morton, William S., Leven Collieries, Leven, - - 1884

Mowat, David M., Summerlee Ironworks, Coatbridge, - 1886
Muir, Robert, Bog Colliery, Hamilton, - - - 1887
Muir, W. W., Coltness Colliery, Newmains, - - 1878
Munro, James, Quarter Iron Works, Hamilton, - - 1879
Munro, Neil, Twechar, Kilsyth, - - - - 1886
Nasmyth, A., Donibristle Colliery, Crossgates, Fife, - 1880
Neilson, Benjamin, Prestongrange Coal Coy., Prestonpans, 1880
Ness, Henry, Benarty Colliery, Blairadam, Kelty,- - 1880
Nevill, Thomas W., 95 Bath Street, Glasgow, - - 1886
Nimmo, Thomas, Fauldhouse Colliery, Fauldhouse, - 1879
Nisbet, Andrew, Kinneil Works, Bo'ness, - - - 1884
Nivison, John, Dykehead Colliery, Larkhall, - - 1886

Orr, Thomas, Shotts Iron Coy.'s Polkemmet Works, Bathgate, - - - - - - 1881

Park, James, Wellhouse, Rutherglen, - - - 1883
Park, Poseph, Allanshaw Colliery, Hamilton, - - 1878
Parker, William, Ellismuir Colliery, Baillieston, - - 1887
Paterson, Hugh, Braidhurst Colliery, Motherwell,- - 1881
Paterson, Thomas, 95 Bath Street, Glasgow, - - 1883
Paul, James, Law Colliery, Carluke, - - - 1881
Penman, James, Kinneil Works, Bo'ness, - - - 1883
Pettigrew, Robert, 66 Flowerhill Street, Airdrie, - - 1881
Phillips, John, Birkenshaw Colliery, Larkhall, - - 1880
*Pitcairn, Gilbert, Eddlewood Colliery, Hamilton, - 1880
Pitcairn, James S., - - - - - 1885

*Deceased.

Pollock, William, 4 Bothwell Road, Hamilton, - - 1884
Prentice, James, Stanrigg Collieries, Airdrie (*Councillor*), - 1881
Prentice, Joseph, Addiewell Colliery, West Calder, - 1880
Prentice, Thomas, Brisdanehill, West Calder, - - 1879

Rattray, Thomas, Lumphinans Colliery, Cowdenbeath, - 1884
Ritchie, James, Gartness Colliery, Airdrie, - - 1885
Robertson, Alex., Benwhat, Dalmellington, - - 1880
Robertson, Archd., Bathville Colliery, Armadale, - - 1880
Robertson, David, Dalquharran Colliery, Maybole, - 1881
Robertson, James A., 54 Blacket Place, Edinburgh, - 1885
Robertson, John, Lanemark Colliery, New Cumnock, - 1880
Robertson, Richard, Newarthill, Motherwell, - - 1887
Robson, Robert, Sydney Mines, Cape Breton, Nova Scotia, 1882
Rodger, Alexander L., Tharsis Mines, Huelva, Spain, - 1884
Rome, J. E., Barblues, Airdrie, - - - - 1886
Ronaldson, James H., 44 Athole Gardens, Glasgow, - 1879
Rorison, John, Springhill Colliery, Kilmarnock, - - 1883
Ross, Michael, Eddlewood Colliery, Hamilton, - - 1878
Rowan, Donald, East Benhar Colliery, Whitburn, - - 1884
Rowan, Henry, Gartgill Cottage, Bothwell, - - 1881
Russell, Alexander, Dalmeny, Edinburgh, - - 1883
Russell, Andrew, Dykehead, Shotts, - - 1887
Russell, Charles, Harthill Colliery, Whitburn, - - 1886
Russell, W. S., Binnend Cottage, Burntisland, - - 1880

Scobie, William, Gilbertfield Colliery, Cambuslang, - 1881
Scott, John, Calder Iron Works, Coatbridge, - - 1879

Seggie, James, Merryton Colliery, Hamilton, - - 1885
Semple, William, sen., Goatfoot Colliery, Galston, - 1881
Sharp, A., Sheardale Colliery, Tillicoultry, - - 1880
Sharpe, George, Wilsontown Colliery, Lanark, - - 1881
Shore, Wm. M., Kaitangata, Dunedin, New Zealand, - 1886
Smith, David, Dalmellington Iron Works, Ayr, - - 1885
Smith, William, - - - - - - 1886
Simpson, Dundas, Ellismuir Colliery, Baillieston, - - 1879
Simpson, James, Windsor Terrace, Windmillhill, Motherwell, - - - - - - 1881
Smith, Daniel, 325 Kirk Road, Wishaw, - - - 1887
Smith, David L., Barr Colliery, Beith, - - - 1888
Smith, Hamilton, Cadzow Colliery, Hamilton, - - 1878
Smith, James, Hallhill Colliery, Baillieston, - - 1881
Smith, John, Cannock Lodge Colliery, Bloxwich, Staffordshire, - - - - - - 1878
Smith, John, Rosehall Colliery, Coatbridge, - - 1880
Sneddon, James B., Oakbank Colliery, Mid-Calder, - 1886
Somerville, William, Bredisholm Colliery, Uddingston, - 1880
Speirs, Adam, Westmains Cottage, Bathgate, - - 1888
Stewart, H., Tranent Colliery, Tranent, - - - 1881
Stewart, Robert, Legbrannock Collieries, Holytown, - 1883
Stirling, John, Bonnybridge, - - - - 1880
Swann, Hugh P., Polknave, Bothkennar, Falkirk, - 1887

Telfer, Henry, Overtown Colliery, Wishaw, - - 1878
Thom, Archibald, Baird's Mines, Lamplugh, Cockermouth, 1881
Thom, James R., Twechar, Kilsyth, - - - 1887

Thomson, A. M'D., Rawyards Colliery, Airdrie, - - 1880
Thomson, George, Dundonald Colliery, Lochgelly, - 1884
Thomson, James, Ross Street, Dunfermline, - - 1883
Thomson, John, Woodhall View, Holytown, - - 1880
Thomson, Richard, Easter Shirva, Kirkintilloch, - - 1878
Thomson, Thomas, Arnloss Cottage, Slamannan, - - 1879
Turner, William, Chapel Colliery, Newmains, - - 1881
Twaddle, William, Ferniegair, Hamilton, - - - 1878

Waddell, Alexander W., Kinneil Iron Works, Bo'ness, - 1883
Waddell, Robert, Blackston Works, Paisley, - - 1880
Waldie, A. B., 25 Douglas Crescent, Edinburgh, - - 1885
Walker, David, Garscadden Works, Bearsden, - - 1880
Walker, David, jun., Bathville Collieries, Armadale, - 1884
Walker, George B., Tankersley Grange, Barnsley, - 1887
Walker, Robert, Bog Colliery, Larkhall, - - - 1881
Walker, William, Cadzow Colliery, Hamilton, - - 1887
Walker, William, Rigside Colliery, Douglas, - - 1880
Wardlaw, John, Garriongill Colliery, Wishaw, - - 1878
Wardlaw, Robert, Hermand Oil Works, West Calder, - 1883
Wardrope, James, Ormiston Station Colliery, Ormiston, - 1887
Watt, Robert, Barncluith Colliery, Hamilton, - - 1887
Webster, David, Burdiehouse Lime Works, Edinburgh, - 1880
Weir, William, Nisbet's Buildings, Hamilton, - - 1884
White, James, Corsehill, Kilwinning, - - - 1885
Wilkie, William, South Arnloss Colliery, Slamannan, - 1885
Williamson, James, Dunbeth Terrace, Coatbridge, - 1880
Williamson, William, 64 Beckford Street, Hamilton, - 1886

Wilson, James, Barncluith Colliery, Hamilton, - - 1880
Wilson, Robert, Longrigg Colliery, Slamannan, - - 1880
Wilson, Robert, Eastgrange Cottage, Dunfermline, - 1880
Wilson, William, Auchinraith Colliery, High Blantyre, - 1879
*Wilson, William, Eastend, Broxburn, - - - 1881
Winning, Andrew, Loganlea Coal Co., West Calder, - 1882
Wood, Thomas, Dalmeny, - - - 1887
Wylie, James, Townhill Colliery, Dunfermline, - - 1880
Wyper, James, Townlands Colliery, Hamilton, - - 1880

*Deceased.

MINING INSTITUTE OF SCOTLAND.

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British Society of Mining Students, Journal, Vol. VII. to IX.—1882 to 1886.
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Cape of Good Hope, Official Handbook, 1886.
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Chemical Industry, Society of, Journal, Vol. III. to VI.—1884 to 1887.
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Chesterfield and Derbyshire Institute of Mining, Civil, and Mechanical Engineers, Transactions—Vol. I. to XV.—1871 to 1887.
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Coal Mining in Great Britain, History of *R. L. Galloway.*

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Colliers' Strike in South Wales. *Alexander Dalziel.*

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